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MYCOTAXON

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MYCOTAXON

Vol. XIII, No. 1, pp. 1-4 April-June 1981

MARCELLE LE GAL: A REMINISCENCE

RICHARD P. KORF

Plant Pathology Herbarium, Cornell University
Ithaca, New York 14853 USA

Marcelle Le Gal, born Marcelle Choquart on February 14th, 1895 at Amiens, France, died in the same city on June 23, 1979. Her influence on mycology, and particularly on the development of the taxonomy of discomycetes, has been immense, even though she only entered the field when she was nearly 40 years of age. Her early publications dealt primarily with discomycetes and showed an exceptional attention to detail and clear deliniation of characters such that I, young and wholly inexperienced, immediately accepted her publications as authoritative and as models of procedure. My own work on discomycetes had only begun in 1944, and in 1947 she sent me her monumental "Recherches sur les ornementations sporales des discomycètes operculés," her just-published doctorate thesis (which was to receive the French Academy's coveted "Prix Montagne."). I was quickly drawn into a lively correspondence with her, and despite the difference in our ages, she cheerfully commented upon and examined problem discomycetes that I sent her over the years, never stinting of her time and advice.

It was 1949 before we were to meet in person, on the occasion of a trip to European herbaria when I was searching for type specimens of species of the Arachnopezizeae for my own thesis studies. At the Laboratoire de Cryptogamie of the Muséum National d'Histoire Naturelle in Paris I was cordially greeted by Professor Roger Heim and his staff, but above all by Mme Le Gal herself. The memory is one I shall ever cherish, for she devoted time and energy to showing me her collections, and the museum's discomycete holdings, including those of her idol (and mine), the eminent Émile Boudier. Quiet-spoken, ever helpful, Marcelle Le Gal was from that moment on to be a major influence in my professional life. Her devotion to the study of fungi, her insight and mastery of the fungi she knew, remain an inspiration to all who knew her. An unexpected surprise to me as a young graduate student was that she entertained me with a sumptuous meal in her Paris apartment, where I was to meet her greatest joy, her husband, Étienne. They had married in 1922 on her return from the United States where she had earned her M.A. at Columbia University.

On several later occasions I was able again to partake of Mme Le Gal's hospitality and kindness during visits to Paris. The last of these was sad beyond any expectation, for when I visited her in 1973 her beloved husband had only recently died. Her grief had caused her to withdraw from duties at the museum to her home in Amiens, and to stop work on the important monograph of the genus Scutellinia that had been occupying her for over a decade. When she learned that I was to visit the Paris museum, she made the unprecedented effort of coming to the museum to talk with me about our taxonomic problems, and offered me the loan of several of her specimens of a critical genus we discussed. Her sadness over the loss of her husband was profound, and had clearly devastated her emotionally, affecting both her personal and professional life. She was soon to turn her back on mycology, perhaps even on humanity, as the result of an unfortunate accident she suffered in Amiens and of her grief over the loss of her constant companion-husband. Mycology's great loss is that her Scutellinia monograph will apparently remain unpublished and incomplete.

Marcelle Le gal is one of the very few to have markedly affected my development as a scientist. From her I learned patience and devotion to detailed study of minute structures as keys to relationships. Not always was I to be in her good graces; particularly because of my insistence on following the Code of Nomenclature and the principle of priority, I became a "Peck's bad boy" in her view. For years I licked the wounds inflicted by her vitreolic attack on "le jeune mycologue américain" in her masterful diatribe against the Code of Nomenclature (Le Gal, 1958). That she eventually forgave my youthful exuberance was one of my great joys.

I shall miss Marcelle Le Gal's cautionary council more than many other mycologists will; our interests coincided closely, and it is in her footsteps that I have trod most often, secure in the knowledge that her obser-

MARCELLE LE GAL (1895–1979)

Photographed by the author in the gardens outside the Muséum National d'Histoire Naturelle, Paris, during the 1954 International Botanical Congress vations were dependable and her sense of taxonomic direction unerring. A kinder, more loving spirit has never before, perhaps, graced mycology.

For those who read French, I commend a touching tribute to her by Patrick Joly (1980), that captures the essence of this most wondrous scientist. Yet another revealing tribute to her contains a complete listing of her mycological papers, the article by her long-time associate in the field and laboratory, Henri Romagnesi (1980).

REFERENCES CITED

JOLY, P. 1980. Marcelle Le Gal (1885-1979). **Cryptogamie, Mycol. 1:** 93-96.

LE GAL, M. 1958. Petite promenade à travers le maquis de la nomenclature. **Rev. Mycol. (Paris) 23:** 121-126.

ROMAGNESI, H. 1980. Mme Marcelle Le Gal (1895-1979). **Bull. Soc. Mycol. France 96:** 125-131.

MYCOTAXON

Vol. XIII, No. 1, pp. 5-15 April-June 1981

DISCOMYCETES EXSICCATI, FASC. IV

RICHARD P. KORF AND SUSAN C. GRUFF

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Ithaca, New York 14853 USA

Twenty-five additional numbers comprise this fourth fascicle of Discomycetes Exsiccati [for distribution of sets, see the note on page 15].

We express particular thanks to Dr. Henry Dissing and to Dr. Sigmund Sivertsen for providing us with holotype material of *Boudiera dennisii* Diss. & Siv. *in* Dissing to issue here as ISOTYPES (No. 77); a second collection of this species was collected by the senior author of this paper in their company and constitutes AUTHENTIC material from a previously unreported locality (No. 78).

As previously noted (Dissing & Korf, 1980), No. 84 in this fascicle constitutes ISONEOTYPE material of *Ruhlandiella berolinensis* Hennings, the type material of which is presumed to have been destroyed in Berlin during the Second World War.

An examination of Rehm's type specimen of *Humaria gregaria* Rehm showed that it has warted ascospores, not smooth as is usually assumed. A smooth-spored variant is issued here (No. 90) as *Trichophaea gregaria* (Rehm) Boud. f. laevispora Korf & Gruff, f. nov., the specimens issued being ISOTYPES:

> *Trichophaeae gregariae f. gregariae similis, sed ascosporis perfecte laevibus differt. HOLOTYPUS: CUP-MJ 611 (ISOTYPI in Korf & Gruff, Disc. Exs. 90 dispersi). PARATYPUS: CUP-MJ 41. On clay bank. Cinchona Botanical Garden, elev. 4750 ft., St. Thomas Parish, Jamaica. Leg. R.P.Korf, leader; J.R.Dixon, K.P.Dumont, R.W.Erb, D.H.Pfister, D.R.Reynolds, A.Y.Rossman & G.J.Samuels. 8.I.1971.*

The typical, warted-spored form is also issued (No. 89) for comparison, as *Trichophaea gregaria* f. *gregaria*.

By far the most abundant of Durand's collections of *Sarcosoma cyttarioides* Rehm *in* Dur., his No. 1305 (= CUP-A 12278), is formally designated here as the LECTOTYPE of that species, and the specimens issued (No. 79) as *Plectania cyttarioides* (Rehm *in* Dur.) Korf are thus ISOLECTOTYPES. [All packets of this collection in the Durand (CUP-D) and Atkinson (CUP-A) herbaria in CUP bear the data for collecting site as "Glen Mary," while the original description (Durand, 1903) states, "Most abundant in Glen Burney." This latter name does not appear on any of the *Sarcosoma* packets in these herbaria.]

Mr. G. Beaton, of Australia, who has consistently provided us with exciting discomycete finds, has generously given us TOPOTYPE material of the elegant species *Underwoodia beatonii* Rifai for issue here as No. 91. Dr. Peter Milan Petersen, of the University of Copenhagen, has contributed the material from Greenland of *Sarcoleotia globosa* (Sommerf. : Fr.) Korf issued as No. 100.

Taxonomic and nomenclatural notes again appear on some of the labels: (79) on *Plectania cyttarioides* as the type species of *Plectania* sect. *Plicosporae;* (87) on Karsten's use of the combination *Scutellinia scutellata,* which while the earliest is not validly published since the generic name was not yet validly published; (89) on Karsten's similarly first use of the combination *Sepultaria gregaria,* likewise not validly published since its generic name had not yet been validly proposed, and on the taxonomic synonymy of *Trichophaea gregaria* var. *intermedia* with *T. gregaria* f. *gregaria;* (95) on an aberant collection or unnamed variant of *Arachnopeziza cornuta* having only 1-celled ascospores; (96) on adoption of *Arachnopeziza leonina* instead of *A. candido-fulva;* (97) on discarding the group "Anomalae" of *Arachnopeziza* since the "granulations" on the hairs of *A. trabinelloides* (sole representative of that group) seem to be more like the resinous excretions sometimes evident in the group "Typicae" than like the granulations on the hairs in *Dasyscyphus.*

ACKNOWLEDGEMENTS

Particular thanks are due the US National Science Foundation, which under a series of grants to the senior author has funded the collecting in Jamaica and the Canary Islands, and to the Fulbright Commission that supported the collecting in Japan. The Okinawa collection was by virtue of support from the US Office of Education, the US Civil Administration of the Ryukyu Islands, and the University of the Ryukyus. Collections from Finland and Norway were financed by the University of Copenhagen and the University of Trondheim. Dr. William Dress, of the Bailey Hortorium, Cornell University, kindly checked the Latin diagnosis.

DISCOMYCETES EXSICCATI

DEPARTMENT OF PLANT PATHOLOGY, CORNELL UNIVERSITY
RICHARD P. KORF & SUSAN C. GRUFF, EDITORS

76. *Anthracobia macrocystis* (Cooke) Boudier, Hist. classif. discomyc. Europe, p. 65. 1907.

On a burnt *Eucalyptus* sp. clear-cut.

At km mark 14, Bosque de la Esperanza, near Pico de las Flores, Tenerife, Canary Islands.

Leg: R.P.K., W.C.Denison, L.M.Kohn & M.A.Sherwood 8.I.1976
Det: R.P.K.

DISCOMYCETES EXSICCATI

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77. *Boudiera dennisii* Dissing & Sivertsen *in* Dissing, Kew Bull. 31: 755. 1977. ISOTYPE

Near a small stream, Nordland, between Berget and Fisksjømoen, 22 km NW of Mo in Rana, Norway.

Leg: H.Dissing, S.Sivertsen & T.Schumacher 6.IX.1975
Det: H.Dissing & S.Sivertsen

DISCOMYCETES EXSICCATI

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78. *Boudiera dennisii* Dissing & Sivertsen *in* Dissing, Kew Bull. 31: 755. 1977. AUTHENTIC

On mud flat at mouth of brook, among *Equisetum*, *Calamagrostis neglecta*, and *Lamprospora ovalispora*.

Loevvajåkka, near Levajok, along Tana River, Finnmark Fylke, Norway.

Leg: S.Sivertsen, H.Dissing & R.P.K. 21.VIII.1978
Det: S.Sivertsen & H.Dissing

DISCOMYCETES EXSICCATI

Department of Plant Pathology, Cornell University
Richard P. Korf & Susan C. Gruff, Editors

79. *Plectania cyttarioides* (Rehm *in* Durand) Korf, Mycologia 49: 110. 1957. [ISOLECTOTYPE of *Sarcosoma cyttarioides* Rehm *in* Durand]

On dead twigs, leaves, etc.

Blue Ridge Mountains, Glen Mary, Blowing Rock, North Carolina.

NOTES: This is the type species of *Plectania* Fuckel sect. *Plicosporae* Korf (*loc. cit.*). R.P.K.

Leg: E.J.Durand (1305) 30.VIII.1901
Det: E.J.D.

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80. *Pseudoplectania nigrella* (Pers. : Fr.) Fuckel, Jahrb. Nassauischen Vereins Naturk. 23-24: 324. 1870.

In clay soil on roots of *Dicranopteris linearis* and rarely of *Pleioblastus linearus*.

University of Ryukyus Recreation Area, Oku, Kumigami-son, Okinawa, Japan.

Leg: R.P.K., K.P.Dumont, Z.Koja & K.Kuroshima 17.III.1966
Det: R.P.K.

DISCOMYCETES EXSICCATI

Department of Plant Pathology, Cornell University
Richard P. Korf & Susan C. Gruff, Editors

81. *Ptychoverpa bohemica* (Kromb.) Boudier, Hist. classif. discomyc. Europe, p. 34. 1907.

On ground in mixed woods.

Lloyd-Cornell Preserve, McLean, New York.

Leg: Mycology Class 2.V.1955
Det: R.P.K.

DISCOMYCETES EXSICCATI

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82. *Pulvinula globifera* (Berk. & Curt. *in* Berk.) Le Gal, Prodr. Flore Mycol. Madagascar 4: 94. 1953.

On soil.

At 1860 ft. elev. in rain forest, El Yunque, Puerto Rico.

Leg: G.Abawi 27.I.1969
Det: R.P.K.

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83. *Pulvinula niveo-alba* Moravec, Česká Mykol. 23: 231. 1969.

On duff.

Juuma-Jäkälävuoma, Kuusamo, Finland.

Leg: S.Sivertsen 25.VIII.1978
Det: S.S.

DISCOMYCETES EXSICCATI

DEPARTMENT OF PLANT PATHOLOGY, CORNELL UNIVERSITY
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84. *Ruhlandiella berolinensis* Hennings, Hedwigia 42: (24). 1903. ISONEOTYPE, designated by Dissing & Korf, Mycotaxon 12: 295. 1980.

On soil.

Burn site along road in *Eucalyptus* grove at km mark 14, Bosque de la Esperanza, Tenerife, Canary Islands.

Leg: R.P.K., R.Fogel, G.L.Hennebert & L.M.Kohn 29.XII.1976
Det: H.Dissing & R.P.K.

DISCOMYCETES EXSICCATI

DEPARTMENT OF PLANT PATHOLOGY, CORNELL UNIVERSITY
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85. *Scutellinia erinaceus* (Pers. : Fr.) O. Kuntze, Revis. gen. pl. 2: 869. 1891.

On mossy wood.

Michigan Hollow, Danby, New York.

Leg: I.J.Gamundí, K.S.Thind, W.C.Denison, R.T.Moore, V.P.Tewari & R.P.K. 9.VIII.1960
Det: R.P.K.

DISCOMYCETES EXSICCATI

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86. *Scutellinia pennsylvanica* (Seaver) Denison, Mycologia 51: 619. 1961 ('1959').

On old wood.

"Big Woods," SW of Ann Arbor, Michigan.

Leg: L.E.Wehmeyer, R.P.K. & al. 19.VII.1948
Det: W.C.Denison

DISCOMYCETES EXSICCATI

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87. *Scutellinia scutellata* (L. : Fr.) Lambotte, Fl. mycol. belge, Suppl. 1: 299. 1887.

On *Fagus* sp.

Lloyd-Cornell Preserve, Slaterville, New York.

NOTES: Neither a generic name "*Scutellinia* (Cooke) Karst." nor the combination "*S. scutellata* (L.) Cooke" was validly published by Karsten (Medd. Soc. Fauna Fl. Fenn. 11: 145. 1884) [ICBN, Arts. 41, 43]. R.P.K.

Leg: M.A.Rosinski II.1952
Det: W.C.Denison

DISCOMYCETES EXSICCATI

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88. *Scutellinia umbrorum* (Fr.) Lambotte, Fl. mycol. belge, Suppl. 1: 300. 1887.

On soil.

Montezuma Wildlife Preserve, Seneca County, New York.

Leg: I.Müller & R.P.K. 20.VI.1962
Det: R.P.K.

DISCOMYCETES EXSICCATI

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89. *Trichophaea gregaria* (Rehm) Boud. f. *gregaria*, Hist. classif. discomyc. Europe, p. 60. 1907.

On soil and rotting plant matter.

Peck Foray, Ashokan, New York.

NOTES: Neither a generic name "*Sepultaria* (Cooke) Karst." nor the combination "*S. gregaria* (Rehm) Karst." was validly published by Karsten (Medd. Soc. Fauna Fl. Fenn. 11: 145. 1884) [ICBN, Arts. 41, 43]. Le Gal's *T. gregaria* var. *intermedia* Le Gal [Rev. Mycol. (Paris) 2: 214. 1937) is a synonym, since Rehm's type specimen also has warted ascospores, not smooth as she assumed. R.P.K.

Leg: D.Malloch, R.P.K. & al. 10.IX.1972
Det: R.P.K.

DISCOMYCETES EXSICCATI

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90. *Trichophaea gregaria* (Rehm) Boud. f. *laevispora* Korf & Gruff, Mycotaxon 13: 5. 1981. ISOTYPE

On clay soil bank.

Trail between Freetown and Wag Water River, near Hardwar Gap, St. Andrew Parish, Jamaica.

Leg: R.P.K., J.R.Dixon, K.P.Dumont, R.W.Erb, 18.I.1971
D.H.Pfister, D.R.Reynolds, A.Y.Rossman
& G.J.Samuels
Det: R.P.K. & S.C.G.

DISCOMYCETES EXSICCATI

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91. *Underwoodia beatonii* Rifai, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., Tweede Sect., 57(3):.69. 1968. TOPOTYPE

In sandy soil and debris under *Melaleuca lanceolata* beside cliff walk, Anglesea camping ground, Australia.

Leg: G.Beaton 23.VIII.1968
Det: G.B.

DISCOMYCETES EXSICCATI

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92. *Urnula craterium* (Schw. : Fr.) Fr., Summa veg. Scand., sect. post., p. 364. 1849.

On soil and wood.

Woods near Westhaven Road, Town of Ithaca, Tompkins County, New York.

Leg: R.J. & K. Smith, K.T.Korf & R.P.K. V.1960
Det: R.P.K.

DISCOMYCETES EXSICCATI

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93. *Wynnea americana* Thaxter, Bot. Gaz. 39: 246. 1905.

On soil in woods.

2.5 miles east of Obi, at crest of hill, elev. 2200 ft., Alleghany County, New York.

Leg: G. & M.Smith, J.Bluhm, L.M.Kohn & R.P.K. 2.IX.1976
Det: G. & M.S.

DISCOMYCETES EXSICCATI

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94. *Arachnopeziza aurelia* (Pers. : Fr.) Fuckel, Jahrb. Nassauischen Vereins Naturk. 23-24: 303. 1870.

On bark and acorns of *Quercus* sp.

France Brook, Alleghany State Park, New York.

Leg: R.P.K. & al. 9.VI.1961
Det: R.P.K.

DISCOMYCETES EXSICCATI

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95. *Arachnopeziza cornuta* (Ellis) Korf, Lloydia 14: 158. 1952 ('1951'). [var.?]

On rotted wood.

Lloyd-Cornell Preserve, Ringwood, New York.

NOTES: Apparently lacking the 2- and 3-septate ascospores by which one usually recognizes this species. R.P.K.

Leg: G.L.Hennebert (3096) & R.P.K. 17.V.1962
Det: R.P.K.

DISCOMYCETES EXSICCATI

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96. *Arachnopeziza leonina* (Schw. : Fr.) Dennis, Kew Bull. 17: 351. 1963.

On a very rotted log.

East end of Lake Shikotsu, Ibari Pref., Hokkaido, Japan.

NOTES: This specimen was reported by Korf (Bull. Natl. Sci. Mus. 4: 392. 1959) as *A. candido-fulva* (Schw.) Korf. Dennis's transfer is correct, since Schweinitz described *Peziza leonina* earlier than *Peziza candido-fulva*, and Fries accepted both. R.P.K.

Leg: S.Imai, S.Kamei, Y.Otani, R.P.K. & al. 20.V.1958
Det: R.P.K.

DISCOMYCETES EXSICCATI

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97. *Arachnopeziza trabinelloides* (Rehm) Korf, Lloydia 14: 169. 1952 ('1951').

On wood.

Margaretville, Delaware County, New York.

NOTES: The "granulations" on the hairs are more like resinous excretions than the granulations of *Dasyscyphus* spp. of the "Typicae" group. This species belongs close to *A. cornuta* in *Arachnopeziza* group "Typicae," and should not be segregated in a group "Anomalae" as was done by Korf *(loc. cit.)*. R.P.K.

Leg: R.T.Pennoyer & R.P.K. 9.V.1959
Det: R.P.K.

DISCOMYCETES EXSICCATI

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98. *Parachnopeziza miniopsis* (Ellis) Korf, Mycotaxon 7: 469. 1978.

On bark.

France Brook, Alleghany State Park, New York.

Leg: R.P.K. & al. 9.VI.1961
Det: R.P.K.

DISCOMYCETES EXSICCATI

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99. *Pezoloma laricina* (Ell. & Everh.) Korf, Phytologia 21: 205. 1971.

On duff, mostly *Tsuga* needles and cones.

Peck Foray XIV, Twin Valleys, Lewis, New York.

Leg: G.Abawi, D.H.Pfister & R.P.K. 15.VI.1968
Det: R.P.K.

DISCOMYCETES EXSICCATI

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100. *Sarcoleotia globosa* (Sommerf.: Fr.) Korf, Phytologia 21: 206. 1971.

On *Sphagnum fuscum*.

Sydprøven (60°21'N, 45°34'W), Greenland.

Leg: P.Milan Petersen (71.162) 30.IX.1971
Det: R.P.K.

DISTRIBUTION OF SETS

The first fascicle of this series was deposited in 11 institutions (Korf, 1958), with 2 additional ones listed by Korf and Gruff (1978) as receiving fascicles II and III. By error they listed "BP = Museum of Natural History, Budapest," whereas the set is actually on deposit at BPU = Institute of Plant Taxonomy and Ecology of Eötvös L. University. A 14th set is now on deposit at Copenhagen, also beginning with fasc. II. The complete list of deposit herbaria is thus:

BPI	(Beltsville)	FH	(Cambridge)*	NY	(New York)
BPU	(Budapest)*	K	(Kew)	PC	(Paris)
C	(Copenhagen)*	LAH	(Lahore)	PR	(Prague)
CUP	(Ithaca)	MICH	(Ann Arbor)	UC	(Berkeley)
DAOM	(Ottawa)			UPS	(Uppsala)

*lacking fascicle I.

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DURAND, E. J. 1903. The genus *Sarcosoma* in North America. Jour. Mycol. 9: 102-104.

KORF, R. P. 1955. Discomyceteae exsiccatae, Fasc. I. Mycologia 46: 837-841. '1954.'

KORF, R. P. AND S. C. GRUFF. 1978. Discomycetes exsiccati, Fasc. II & III. Mycotaxon 7: 185-203.

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ALTERNARIA THEMES AND VARIATIONS

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PROLOGUS

Being the initiation of a series of observations on *Alternaria* species, in this instance on some whose nonbeaked conidia very rarely occur in chains (*A. molesta sp. nov., A. mouchaccae nom. nov.*) and others whose erostrate conidia proliferate in chains by means of interpolated conidiophores (*A. chlamydospora, A. limaciformis sp. nov.*, and two commonly misrepresented phytopathogens, *A. triticina* and *A. longipes*).

I. EROSTRATAE, SOLITARIAE

Most species of *Alternaria* produce conidia in chains, some readily and abundantly under conditions of either nature or culture (e. g., *A. tenuissima* (Kunze in Nees & Nees ex Persoon) Wiltshire), others sparsely and perhaps only tardily after manipulation of culture medium, light quality, and temperature. This latter reluctantly catenulate group includes, among others, common phytopathogens whose conidia are thin walled and filamentously rostrate (e. g., *A. zinniae* M. B. Ellis) as well as others whose conidia are relatively thick walled and erostrate (e. g., *A. radicina* Meier, Drechsler & Eddy).

Alternaria species of a third group produce two conidia in a chain so rarely, under any condition reported or observed thus far, that any chain can be considered little more than an aberration. Two notable members of this group are *A. chrysanthemi* Simmons & Crosier (Simmons 1965) and *A. helianthi* (Hansford) Tubaki & Nishihara (1969). Both of these species are phytopathogens; the nonbeaked conidia of both are relatively large for the genus, with lengths up to 120µm and 110µm respectively (Fig. 1).

An additional member of this group with erostrate, solitary conidia is known in the form of a small-spored species isolated from a skin lesion of a captive harbour porpoise (by S. Andersen, Odense, Denmark; transmitted by G. A. de Vries, Baarn, The Netherlands, as CBS M 339.77). It is reported here as novel on the basis of examination of axenic cultures, primarily on potato-carrot agar, hay extract agar, and 20% V-8 juice agar (hereafter as PCA, Hay, V-8; see Stevens 1974), in a diurnal fluorescent light/dark cycle, at 22 C .

1. *Alternaria molesta* Simmons, *sp. nov.* (Fig. 1)
   [*molesta* = troublesome (to both *Phocaena* and Simmons, though in different ways)]

*Ex culturis in agaro PCA descripta. Coloniae griseobrunneae, lanuginosae, postea atrobrunneae, applanatae. Mycelium initio ex hyphis septatis, ramosis, subhyalinis vel pallide stramineis, levibus, 3.5-5.0*μm *crassis compositum. Conidiophora simplicia, singulatim ex lateribus hypharum oriunda, recta vel flexuosa, cylindrica, pallide flavo-brunnea, levia, 0-10 septata, plerumque 4-5*μm *crassa, usque ad 100 (plerumque 5-20)*μm *longa, apice rotundato et uniporoso, raro geniculata. Conidia solitaria, subcylindrica, ovoidea, obclavata vel ellipsoidea, septis transversalibus plerumque 3-6, longitudinalibus nullis vel paucis, ad septa definite constricta, pallide straminea, levia, 15-38 x 7-12 (plerumque 27 x 12)*μm. *Origo typi: ex laesione pellis Phocaenae phocaenae, Odense, Daniae. Typus: partes ex Simmons 32-075 (CBS M 339.77) desiccatae et in BPI, CBS, DAOM, IMI, NY conservandae.*

The type isolate is stable and predictable in its growth and sporulation characteristics under specified culture conditions. It grows well on PCA and V-8 (15mm radially in 4 da), producing colonies that are dark olive-brown with a shallow aerial layer of paler woolly hyphae. Conidium production occurs initially on hyphae near the substrate surface but spreads gradually to the intertwined aerial elements. After the agar surface of an entire culture plate has been overgrown, the colony becomes almost opaque because of the very dark color of both the submerged and the aerial hyphae. Although the mycelium of colonies on Hay is scarcely visible, it gives rise to conidia readily and abundantly.

Conidia of *A. molesta* are produced one per conidiophore tip; conidiophore tip proliferation (geniculation) is uncommon. Among many hundreds of conidia viewed in slide preparations, only half-a-dozen had an apical 1-cell extension with a terminal scar, and thus presumably had served as the basal unit in a chain of two conidia. The color of conidium and conidiophore walls is so dilute that septa and disjunction scars appear in bold contrast in transmitted light. A very high percentage of conidia mature as ellipsoid to ovoid units with three transverse septa and at a size of about 27 x 12µm. The conidium population is, for an *Alternaria* species, remarkably restricted in morphological variation, with very little tendency to produce longitudinally asymmetrical or excessively cellular entities. Fig. 1 illustrates conidiophores and a representative range of *A. molesta* conidium shape, size, and septation. Conidium outlines for *A. chrysanthemi* (Fig. 1, lower left) and *A. helianthi* (Fig. 1, lower right) are included for purposes of comparison.

2. *Alternaria mouchaccae* (Fig. 2)

Arid and semidesert soils harbor remarkable numbers of phaeodictyosporic hyphomycete species (Durrell & Shields 1960; Kuehn 1960; Ranzoni 1968; States 1978). New taxa almost inevitably have been unearthed and described in *Ulocladium*, *Embellisia*, and *Alternaria*. Pertinent to the present discussion is a species published as *Ulocladium chlamydosporum* Mouchacca (1971), which was described as new on the basis of several isolates from arid and newly cultivated soil of the New Valley region of Egypt. A second dematiaceous entity, often associated with *U. chlamydosporum* in nature and morphologically similar to it, later was published as a new species *Alternaria chlamydospora* Mouchacca (1973). Study of representative strains of these two species (IMI 156434 and IMI 156427 respectively; EGS 31-061 and 31-060) reveals that they are congeneric in *Alternaria*. Their morphological similarity and natural association in the soil tempts one to speculate that they also may be conspecific although culturally in different phases of progressive degeneration (a condition noted by Mouchacca, 1971). However, relying to the greatest extent possible on comparisons of 1-conidium reisolates on PCA and Hay agars, of conidiogenesis, and of conidium development before typical cell distortion begins (Figs. 2 & 3), I conclude that there are two distinguishable species, *Alternaria chlamydospora* Mouchacca (discussed below as species no. 3) and *Alternaria mouchaccae* Simmons, *nom. nov.* [≡ *Ulocladium chlamydosporum* Mouchacca, Revue de Mycologie 36(2): 120, 1971; *non A. chlamydospora* Mouchacca, 1973].

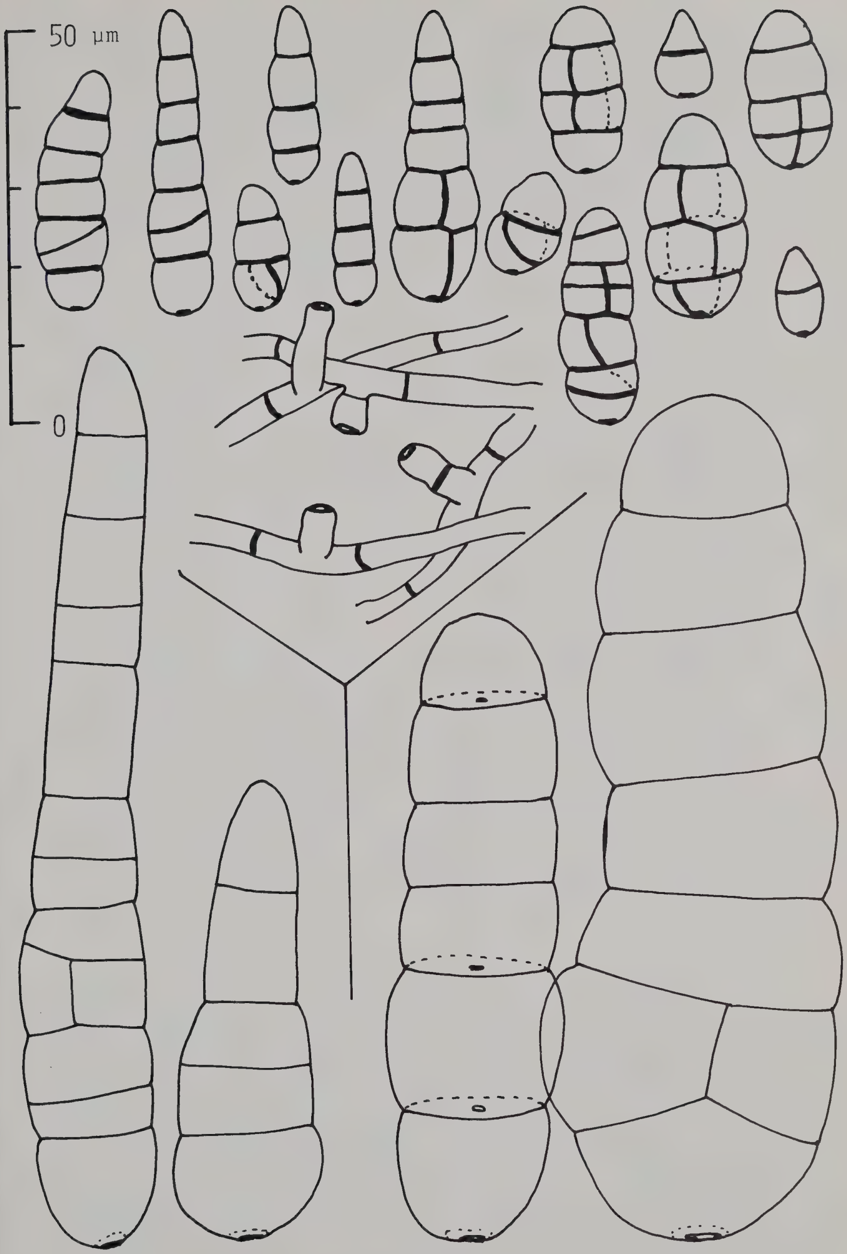

Fig. 1. Alternaria molesta ex Type (at top), from culture on PCA; A. chrysanthemi (lower left); A. helianthi (lower right).

A. mouchaccae is yet another example of a species that produces nonbeaked solitary conidia when grown on media of low nutrient content. False conidial beaks (secondary conidiophores) are extremely rare under such conditions; only two were found among hundreds of conidia examined. A few young conidium initials might be misinterpreted as ulocladioid on the basis of a narrow isthmian attachment to the conidiophore. However, most young conidia are spherical or ovoid from the beginning and have bases in close contact with conidiogenous cells, which themselves exhibit conspicuously pigmented areas around the terminal disjunction scars — characters more nearly typical of *Alternaria* than of *Ulocladium*. Conidium basal scars appear always to have been pushed into an eccentric position following the division of any basal cell by a vertical or oblique septum. Enlarging conidia often become conspicuously swollen and distorted, especially when produced in colonies on V-8 agar. The strain studied, "*cultura typica*" (Mouchacca 1971), exhibits abundant nonsporulating hyphal overgrowth, although conidium production on nonaerial mycelium remains good as long as only conidia are used as inoculum in serial transfers.

Considerable experience with moderately unstable isolates of this sort suggests that hyphal chlamydospores, stromatic cellular masses, and progressive degeneration originally described for this material, and still present, may be characteristic of the typical culture rather than of the species *in toto*, and that focusing attention on the morphology of conidia before they become distorted may permit recognition of *A. mouchaccae* among future isolates, whether or not accessory structures are present.

II. EROSTRATAE, PROLIFICANTES

The character "conidium with beak," i. e., a conidium with an apical portion morphologically distinguishable from the septate sporebody, strongly influences the commonly held generic concept of *Alternaria*. Neergaard (1945) discussed the nature of the conidial beak, emphasizing its species-diagnosis utility and making a strong point of differentiating between "true beak (eurostrum)" as an integral part of the conidium and "false beak (pseudorostrum), formed like the conidiophore of the species concerned." The nature of the *Alternaria* false beak remains poorly understood, however, if we judge on the basis of much of the available descriptive literature and posited ranges of conidium length. Evaluation of this literature, a complex

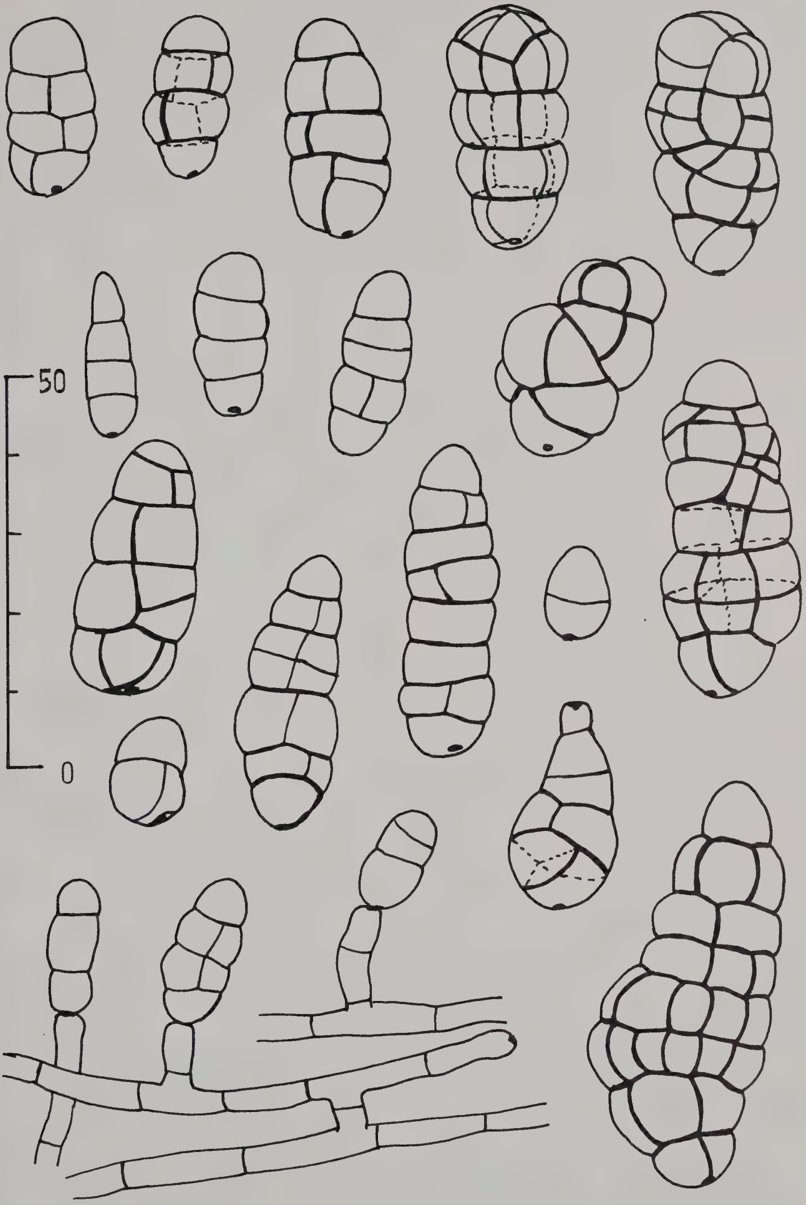

Fig. 2. *Alternaria mouchaccae* ex Type, from PCA culture.

task, is needed in aid of correct *Alternaria* determinations, especially for pathogens that figure largely and too often with incorrect names in the international literature.

Conidia of four species discussed in Section I above typically have no portion that can be distinguished objectively as a beak, true or false (an extremely rare pseudorostrum being exceptional). Conidia of a second, relatively large group of species are characterized as being nonbeaked when produced but having a marked ability to produce chains through the agency of secondary conidiophores (false beaks), readily and sometimes even exuberantly.

3. *Alternaria chlamydospora* Mouchacca (Fig. 3)

The kinds of conidium enlargements that characterize *A. chlamydospora* (Mouchacca 1973; his Figs. 2 & 3) could support a suggestion that mycotaxonomists ignore the fungus and its name as representing a cultural monstrosity. A high percentage of conidia become grossly swollen and distorted; conidiogeny may become so disorganized that lateral hyphal branches, recognizable as potential conidiophores, sometimes enlarge abruptly terminally into quite recognizable *Alternaria* conidioids (Mouchacca, l. c., Fig. 3) instead of arising in the tretic mode of conidium ontogeny believed to be typical of the genus. Most definitions of "chlamydospore" would encompass such cellular oddities, even though some of them, at least, are able to produce typical apical conidiophores and, presumably, secondary conidia.

Eliminating this organism from taxonomic consideration would be inappropriate for several reasons, two important ones being (1) that the conidiogeny apparatus and the morphology of a respectable portion of conidia are distinctive and predictable up to the point at which individual cells become aberrant and (2) that recognizable chlamydosporic, conidioid isolates (as contrasted to conidium verum strains) are not uncommon among isolates of dematiaceous hyphomycetes and for practical purposes, including medical and phytopathological, cannot be ignored.

As for *A. chlamydospora* as a recognizable species, its individual conidia vera lack a definable beak. However, apical and even lateribasal secondary conidiophore production is common, as is subsequent chain formation. It would be idle to speculate whether or not this species exists in nature in a nonchlamydosporic state. Nevertheless, it would be a fascinating exercise (1) for an experimental systematist to attempt to isolate this fungus from whatever aberrational influence or factor is present and (2) for a

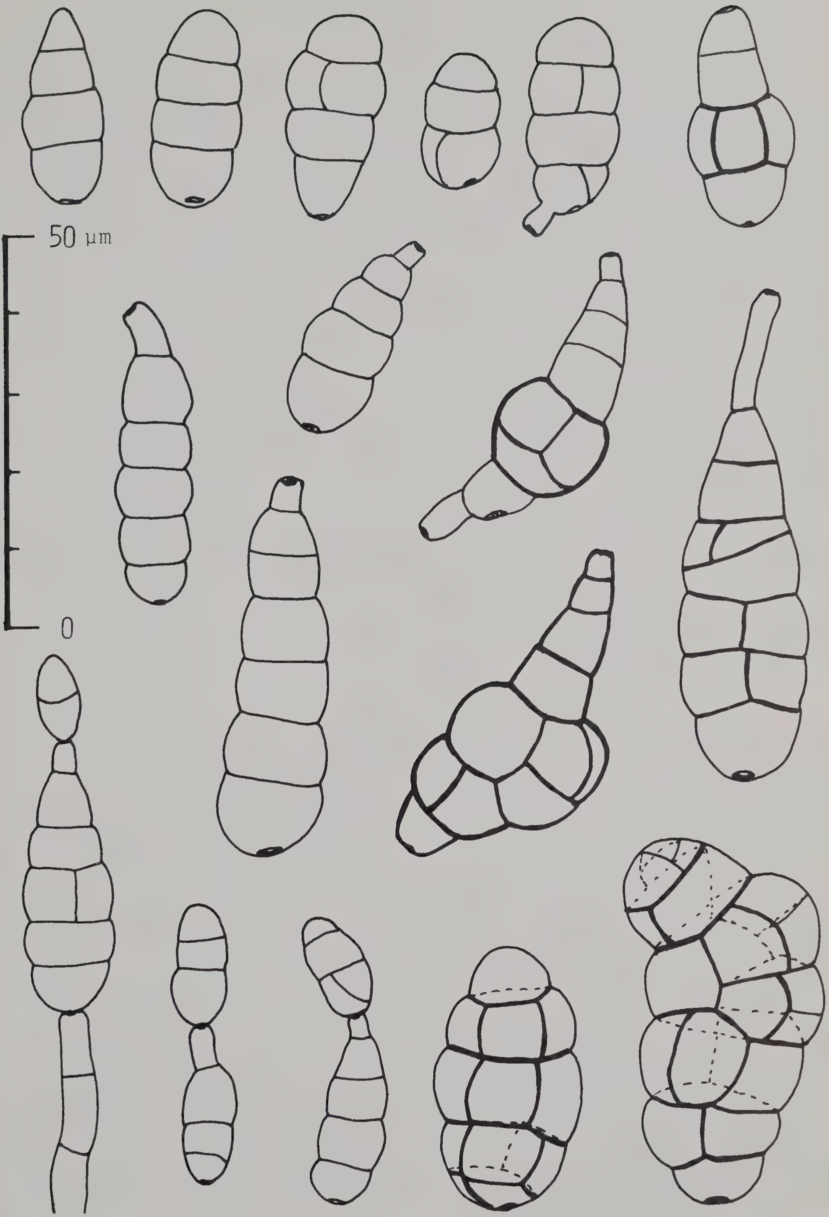

Fig. 3. Alternaria chlamydospora ex Type, from PCA culture.

mycopathologist to characterize the factor itself.

4. *Alternaria limaciformis* (Fig. 4)

A singular isolate received from the Commonwealth Mycological Institute, Kew, in 1954 has remained nameless since that time (along with several other such offerings) while preconceived ideas on *Alternaria* were being tested (Simmons 1967, 1978) and somewhat similar genera *Ulocladium* and *Embellisia* (Simmons 1967, 1971) were being segregated. Conidia of this isolate are solitary for the most part (well over 90%) and have no definable beak. However, secondary apical and lateribasal conidiophores are fairly common, with chains of two conidia equally common and of three rare but easily detectable in each colony scanned. Conidia often exhibit one or two minor arcs of curvature, even at the very young stage preceding septation, thus appearing somewhat vermiform. As transverse, longitudinal, and oblique septa are formed, especially in the central two quarters of enlarging conidia, the curvature often becomes accentuated two- or even three-dimensionally. The somewhat stubby, slightly swollen, sigmoid outline of many conidia bears a fancied resemblance to that of *Limax* garden slugs.

Alternaria limaciformis Simmons, *sp. nov.*

Ex culturis in agaris descripta. Coloniae in PCA planae, griseo-brunneae, atrantes; in V-8 planae, atrobrunneae, rubescentes; in Hay inconspicuae attamen conidiogenae. Mycelium ex hyphis dilute brunneis, 3-4µm diam., necnon atrobrunneae, 6-7µm diam., in funiculis radiantibus compositum. Conidiophora recta vel acclivia, simplicia vel ramosa, ex hyphis submersis et aeriis oriunda, usque 5µm diam. et plerumque 150-200µm longa, ad quinque genicula sporifera praebentia. Conidia plerumque solitaria, aliquando brevicatenulata; initio ovoidea vel plerumque brevivermicularia, hyalina, levia; denique late ovoidea, ellipsoidea, flexa vel limaciformia, straminea, 30-45 x 9-18µm; septis transversalibus plerumque tribus ad sex et longitudinalibus obliquisve nullis vel in quoque cellula centrali uno ad duobus. Habitatio typi: solum prope Goole, Yorks., Britannia. Typus: partes ex Simmons 7-086 (IMI 52976, leg. A. R. Cottrell 307.2) desiccatae et in BPI, CBS, DAOM, IMI, NY conservandae.

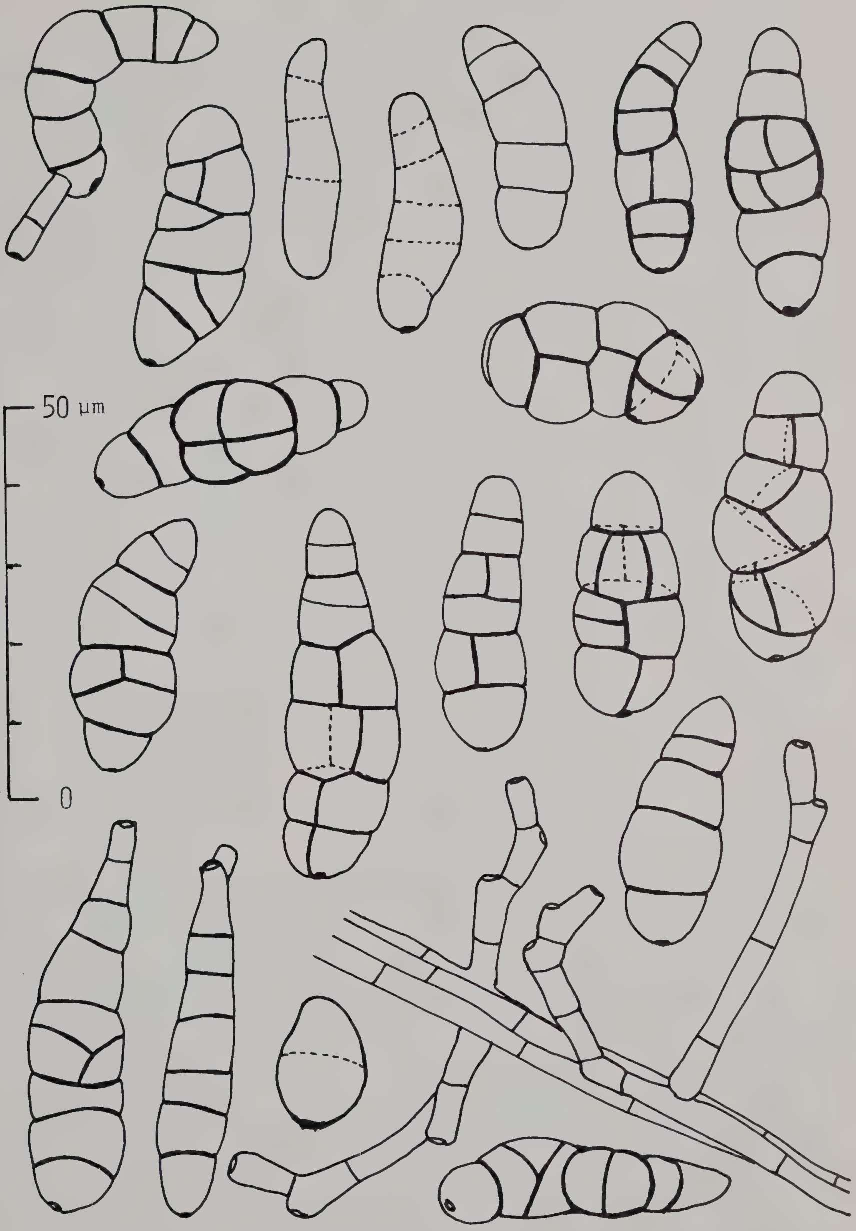

Fig. 4. Alternaria limaciformis ex Type, from PCA culture.

5. *Alternaria triticina* (Fig. 5)

A. triticina Prasada & Prabhu (1963), a striking species originally described from wheat leaves and, fortunately, represented in culture by an isolate from the type material, is another example of an *Alternaria* with nonbeaked conidia that readily produce apical outgrowths and, subsequently, short chains of two and three conidia. In my experience the great bulk of spotted wheat leaves that reach laboratories in both tropical and temperate regions as *Alternaria* specimens bear members of the taper-beaked *Alternaria alternata* (Fries) Keissler and *A. tenuissima* groups and, commonly, the *Alternaria* state of *Pleospora infectoria* Fuckel. *A. triticina* specimens are so rare in major *Alternaria* reference collections, including my own, that it seems likely that the species itself either is rare (for such a common and intensively cultivated host) or that it does not sporulate readily in nature, and thus escapes discovery on most diseased specimens.

A representative isolate (EGS 17-061, ex ITCCF 1186 G. C.) from the type specimen remains in good sporulating condition almost 20 years after its isolation. Some of its distinctive characteristics deserve review, in view of the circumstance that its original description lacks illustrations and is misleading about conidium surface ornamentation and that the influential published illustrations of M. B. Ellis (1976) appear either to be based on atypical material or to emphasize features (e. g., conidia gradually tapering distally and with smooth walls) that are not typical of the species.

Conidia of typical *A. triticina* terminate distally in an obtusely conical cell. Conidia produced in nature and in culture seldom taper into a rostrate structure, although the terminal cell often renews growth abruptly and produces a morphological and functional conidiophore. Conidium size typically does not exceed 60 x 25μm. Ornamentation of the conidium wall is shallow and inconspicuous, though present, in the type specimen; in the type isolate verrucae are so abundant on the conidium surface (6-8 per 10μm) and so conspicuous as to make observation of secondary conidial septa difficult. Young conidia are ovoid, becoming ellipsoid. A prominent, perhaps useful diagnostic characteristic of enlarging conidia is the tendency for them to become distinctly inequilateral.

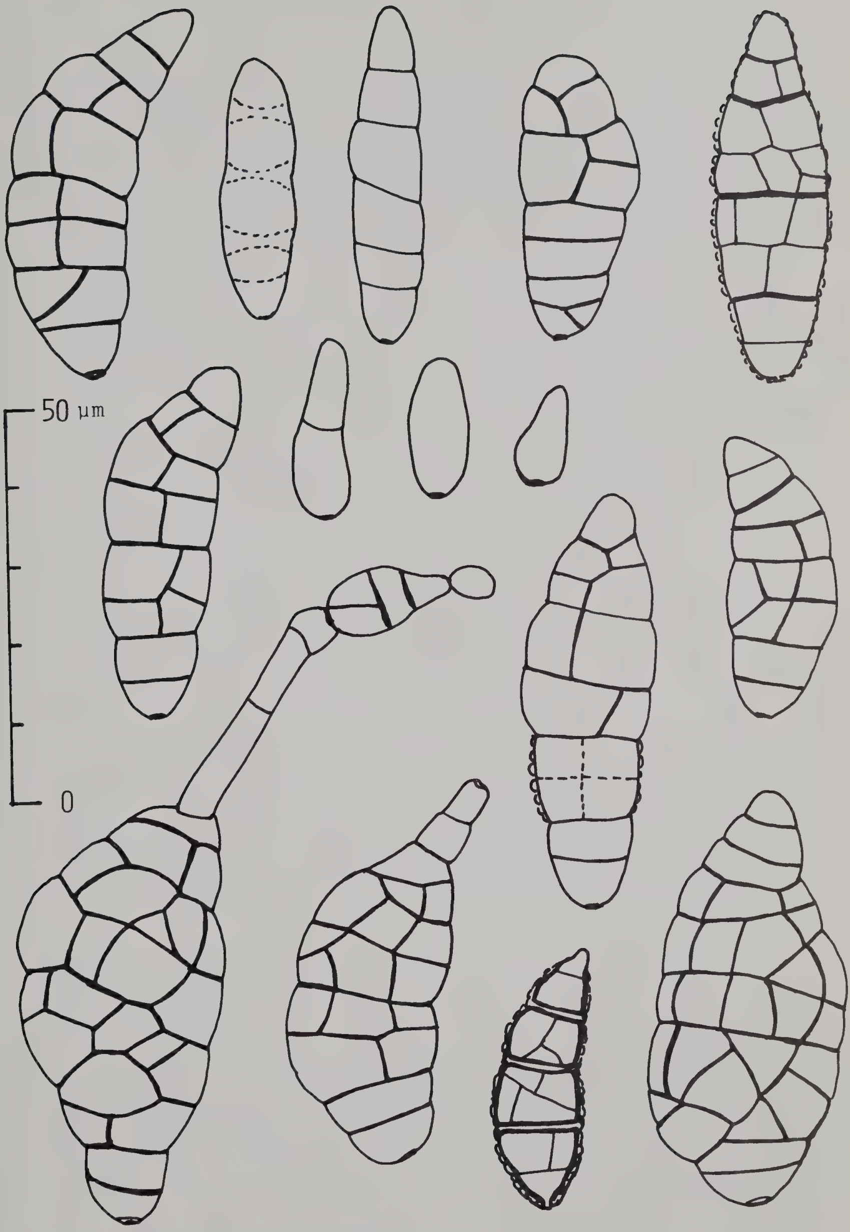

Fig. 5. Alternaria triticina ex Type, from PCA culture.

6. *Alternaria longipes* (Fig. 6-8)

The fungus species named *Alternaria longipes* (Ellis & Everhart) Mason has suffered considerable indignity at the hands of mycosystematists, nomenclaturists, phytopathologists, and tobacco farmers. Amends are due here as an introduction to this further example of a species with beakless conidia that readily generate apical conidiophores.

A collection of diseased tobacco leaves was received by J. B. Ellis with a letter dated Oct. 7, 1891, from Gerald McCarthy, North Carolina Agricultural Experiment Station, Raleigh. This material typifies the description of *Macrosporium longipes* Ell. & Ev. (1892); it still exists (NY), packeted in McCarthy's original letter with a scrap of paper carrying one of Ellis's characteristic sketches of a conidium and notes: "Brown spot"; "35-45µ" (length of conidium body), "15-30µ" (length of basal "stipe," a common misinterpretation at the time of an apical conidiophore or beak).

E. W. Mason (1928) transferred the Ellis and Everhart epithet to *Alternaria*. His decision to do so was based on a J. C. F. Hopkins isolate from Rhodesian tobacco of "an *Alternaria* of the *A. solani* type," which large-spored species the isolate later was considered to be. Mason soon recognized his misdetermination, inscribing a copy of his 1928 paper sent to John A. Stevenson: "Alas I got the wrong one. Tisdale is preparing to pounce on me over this." The error was unfortunate in its influence on phytopathologists working with tobacco diseases at the time; it was corrected in the Appendix of Hopkins's *Tobacco Diseases* (1956, pp. 163-164), along with comments on three, perhaps four distinguishable species of *Alternaria* associated with tobacco leaf diseases.

W. B. Tisdale and R. F. Wadkins (1931) also proposed a new combination *A. longipes* after making a detailed experimental study of the brown spot disease in Florida and of the fungus considered to be causal. The evidence of their descriptions and illustrations suggests that they were working with the same fungus that Ellis and Everhart had described. The work of Tisdale and Wadkins, because of its experimental approach, also was influential, but the correct attribution of the name in *Alternaria* remains *A. longipes* (Ell. & Ev.) Mason by priority of publication.

North Carolina, which supplied the type material of *A. longipes*, has continued to support interest and research in many aspects of this commercially important disease and

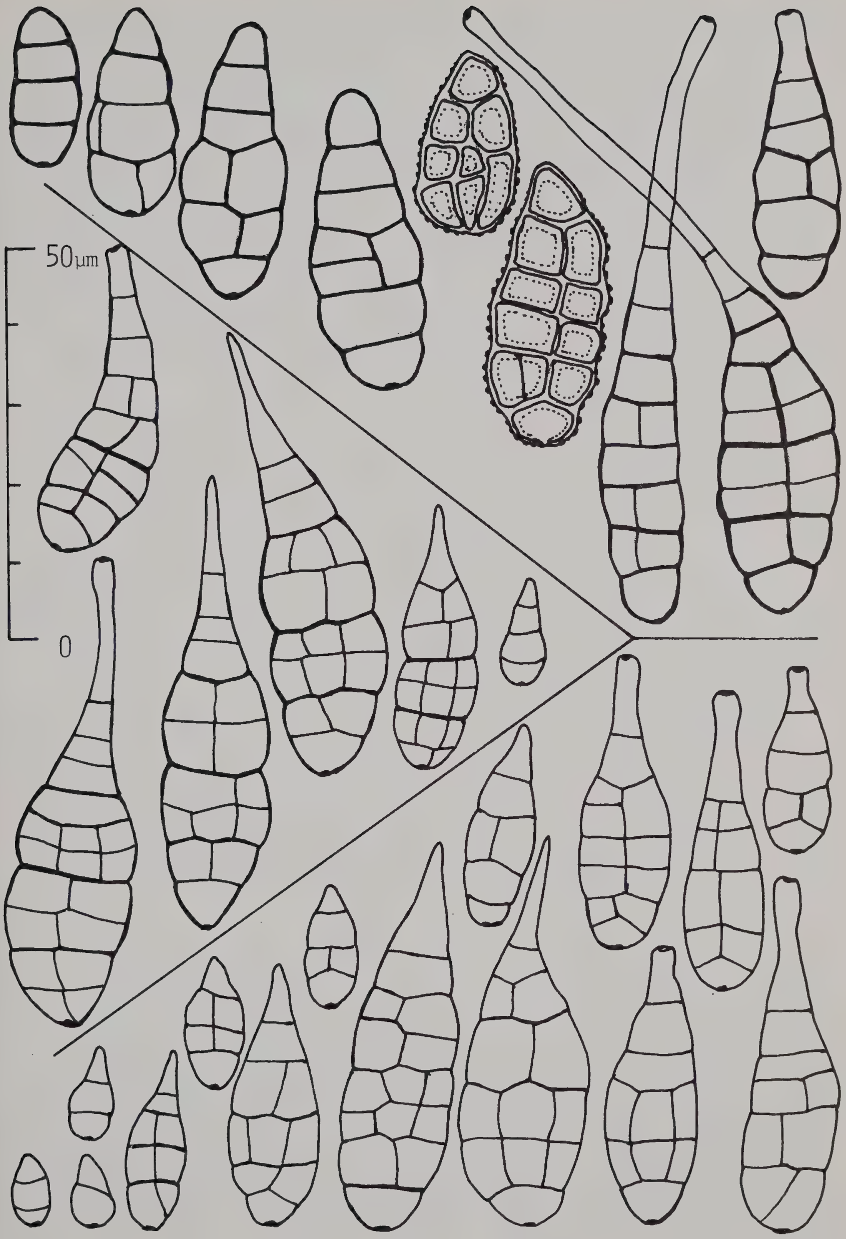

Fig. 6. Comparison of conidia selected from type specimens of Alternaria longipes (at top), A. tenuissima (left center) and A. alternata (bottom).

associated fungi for about 90 years. Reports on much of the tobacco brown spot work of this period reached publication using the name *A. longipes* for whatever small-spored species was/were present. The practical difficulty of distinguishing *A. longipes* from other species commonly present on tobacco led G. B. Lucas (1971) to suggest that *A. longipes* and genericotypical *A. alternata* are the same species. The suggestion is seductive in its ease of application to determinations of field specimens; it is unwarranted, however, on the basis of the literature on the subject. To the extent that tobacco disease work of the past decade is bracketed with the single fungus name *A. alternata*, the work requires reconsideration with respect to the identity of the fungus species actually involved.

Alternaria alternata (the name legitimized at present over the earlier *A. tenuis* Nees) may or may not be associated with brown spot lesions of tobacco in North Carolina; the species *A. longipes*, however, certainly has such a relationship with much pertinent material, not only in the U.S.A. but also in tobacco production areas of other parts of the world. Many field specimens and isolated strains among scores that have reached me are readily identifiable morphologically as *A. longipes*, and many of the latter have been characterized to me by the donors as being virulent pathogens under experimental conditions.

Examples of reputedly virulent strains that are morphologically typical *A. longipes* include EGS 30-101 (ex C. E. Main M-74, recd 1973); EGS 16-135 (ex G. B. Lucas R-66, recd 1963); EGS 30-033 (ex J. R. Stavely A-5, recd 1971); EGS 30-034 (ex J. R. Stavely A-3, recd 1971); EGS 30-080 (ex 1971 Fungicide Oxford #163 (slow), recd 1971); EGS 17-179 & 17-180 (ex D. C. M. Corbett, recd 1966 via IMI 123399 & 123400).

The distinctness of *A. longipes* from *A. alternata* and from the commonly encountered species *A. tenuissima* is illustrated (Fig. 6) with outlines of a range of conidia from the type specimen of each species. An excellent modern field collection of *A. longipes* (representing several received in 1973 from E. K. Sobers, Tifton, Georgia) is EGS 33-095, illustrated in Fig. 7.

In culture *A. longipes* produces conidia successively and so rapidly in chains that the transition region between conidium body and new conidiophore tends to be poorly defined. Nevertheless, most conidia reveal the site of the change from conidium to beak through a slight outline constriction and by reductions in wall ornamentation, color, and thickness. Conidium illustrations in Fig. 8 emphasize several features of cultured material: the extraconidial nature of the conidiophore/beak and the fundamentally erostrate nature of *A. longipes* conidia; the somewhat reduced size of conidia produced in culture; and the remarkable thickness of conidium walls, which is observable in some field material and which is accentuated in conidia produced in culture on PCA. The comparatively restricted growth of *A. longipes* on V-8 agar, stressed by Sobers and Doupnik (1969) in their studies of the species, has proved a particularly useful differential diagnostic feature of pure, stable isolates of the species.

The voluminous international literature and the unpublished virulence/aggressivity information shared with me

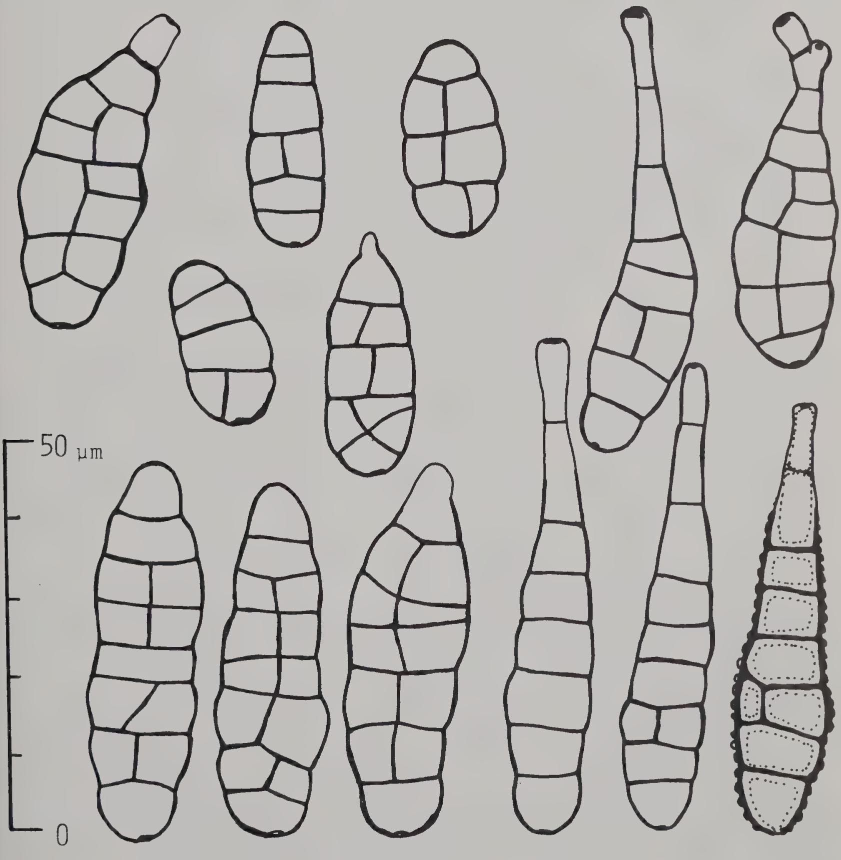

Fig. 7. Alternaria longipes, representative conidia from a modern field collection (Sobers, 1973; EGS 33-095).

by several phytopathologists suggest that many strains of morphologically distinct *A. longipes* are pathogenic to tobacco plants, that others have degenerated in pathogenicity during their years in culture, that other distinguishable species of *Alternaria* very commonly are found on and isolated from tobacco lesions, and that the total picture, insofar as species of *Alternaria* are involved, needs review.

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Continued support by the several herbaria and mycological institutions noted by abbreviations in the text, by the National Science Foundation (DEB79 04189), and by the U. S. Army Natick Research and Development Command is gratefully acknowledged.

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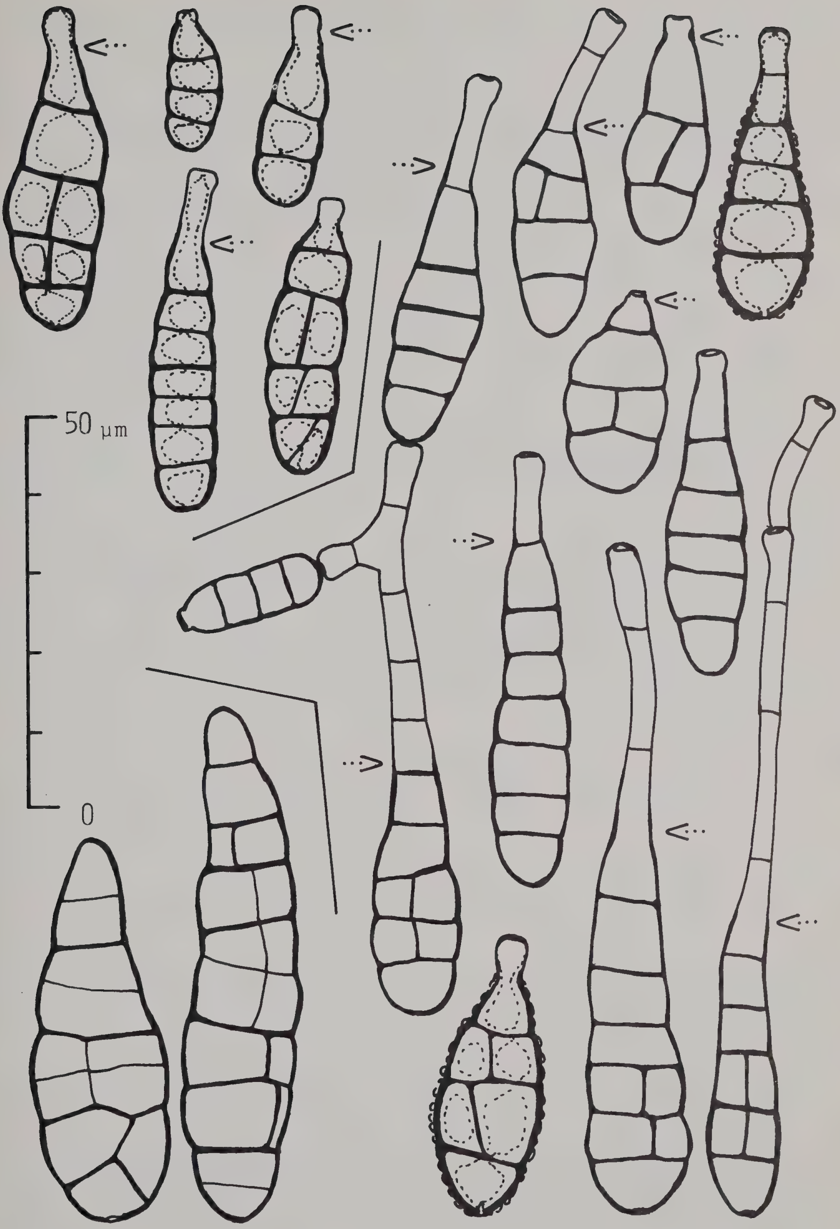

Fig. 8. Alternaria longipes conidia: large erostrate from nature (lower left), smaller pseudorostrate from Hay (right) and PCA (upper left); arrows indicate conidium/conidiophore transition zone. Conidium walls usually ornamented, thick.

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MYCOTAXON

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STUDIES IN TROPICAL CORTICIACEAE (BASIDIOMYCETES) III. TWO NEW SPECIES OF LAXITEXTUM

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SUMMARY

Laxitextum incrustatum nov. sp. and *L. lutescens* nov. sp. are described from Africa. A key to the known species in the genus is provided.

The genus *Laxitextum* was described by Lentz (1955) in a rather wide sense, but was later emended and restricted by Boidin (1958). The type species *L. bicolor* is widespread and is illustrated in Eriksson and Ryvarden (1976). Talbot (1951) reported *L. bicolor* from South Africa, Nigeria, Kenya and Uganda, while Boidin (1960) reported it from Zaire. During our work with African corticioid fungi, we came across two new species in the genus which are described below.

Key to species

1. Hymenium and pileus cream to deep yellow, gloeocystidia distinctly amyloid, spores 3,5-4 x 3-3,5 um......*L. lutescens*

1. Hymenium white to pale cream, pileus if present, dark brown, gloeocystidia non-amyloid or only very weakly so, spores 4-5 um long..............................2

2. Trama and pileus, if present, dark brown, tramal hyphae brown and smooth, spores oblong ellipsoid, 4-5 x 2,5-3 um..*L. bicolor*

2. Trama cream, pileus not known, tramal hyphae pale yellowish and encrusted, spores broadly ellipsoid 4-5 x 3-3,5 um............................*L. incrustatum*

LAXITEXTUM INCRUSTATUM Hjortst. & Ryv. nov. spec.
Fructificatio mollis, plerumque resupinata, late effusa, 0.2 - 0.4 mm crassa; tramate distincto evoluto; hymenium leve, cremeum vel obscure ochraceum, leniter rimosum; systema hyphale monomiticum; hyphis cum fibulis, rectis, luteobrunneis, reniformibus, plerumque incrustatis, 3.5 - 4 um latis, aliquot oleosis, amyloidibus; gloeocystidia cum schizopapillis, fusiformia, subulata vel obtusa, 70 - 80 x

5 um, vulgo non-amyloidibus; basidia anguste clavata, 15 - 25 x 4 - 5 um, 4 - sterigmatibus; sporis subglobosis vel ellipsoidibus, echinulatis, (4-)4.5(-5) x 3-3.25 um, valde amyloidibus.
HOLOTYPUS: Africa. Tanzania. Arusha Prov. Arusha Nat. park. Mt. Meru E. slope, road to the crater alt. 1800-2300 m. 8. Feb. 1973. L. Ryvarden 10108 (O).
PARATYPI: do. L. Ryvarden 10048; Tanzania: Kilimanjaro Prov. Mt. Kilimanjaro W slope, W. Kilimanjaro Forest Sta. alt. c. 1800 m. 10.-11. Feb. 1973 L. Ryvarden 10198; Tanga Prov. Lushoto distr., Usambara Mts. Magamba c. 4 km N of Lushoto, alt. 1600-2000 m. 21.-22. Feb. 1973. L. Ryvarden 10750. All in O.
USA: Louisiana, St. Martinsville, no date, Leg. A.B. Langlois. (TRTC), do. Sept. 32. 1889, Leg. A.B. Langlois 2095 (TRTC). Without locality, Sept. 1913, on oak branches lying on the ground, C.G. Lloyd 46777 (TRTC).

Fruitbody soft, resupinate and widely effused, but loosening at the margin which is striate or fibrillose, about 0.2-0.4 mm thick with the trama distinctly developed, hymenium smooth, creamish to dull ochraceous, more or less cracked. Hymenial layer somewhat more dense than in the other species of the genus. Hyphal system monomitic with loosely interwoven tramal hyphae, golden yellow, straight and encrusted. The hyphal wall is thickened and the diameter may vary from 3,5 to 6 um, often with adventitious septa between each clamped cell. Subhymenial hyphae more irregular, pale coloured to hyaline. Oleiferous hyphae occur more or less abundant, usually with a slight amyloid reaction. All hyphae with clamps. Gloeocystidia arising from the tramal layer, fusiform, subulate or with obtuse apex, sometimes with schizopapilles, generally 70-80 x 5 um, but the length varies considerably and they may sometimes be up to 100 um or more, mostly without amyloid reaction, negative in benzaldehyde. Basidia narrowly clavate, 15-25 x 4-5 um, with four sterigmata. Spores subglobose to ellipsoid, echinulate, (4-)4.5(-5) x 3-3.25 um, strongly amyloid.

Remarks. The species is somewhat similar to L. lutescens (see below), but is easily distinguished by its slightly larger spores, encrusted hyphae and paler hymenium. Furthermore, all known specimens are resupinate. The hymenial layer is denser and the gloeocystidia are non-amyloid or only very weakly so. Because of its well developed subiculum and negative reaction in benzaldehyde the species seems to belong in Laxitextum and is related to L. bicolor. However, it also has similarities to a group of species in Gloeocystidiellum such as G. propinquum (Jacks.) Parm., G. sibiricum Parm., and Gloeocystidium lacticolor Bres. (type examined). The main differences are the distinct subiculum in Laxitextum and that oleiferous hyphae are lacking in these species and the sulfovanilline reaction is positive, (except in G. lacticolor?). Another

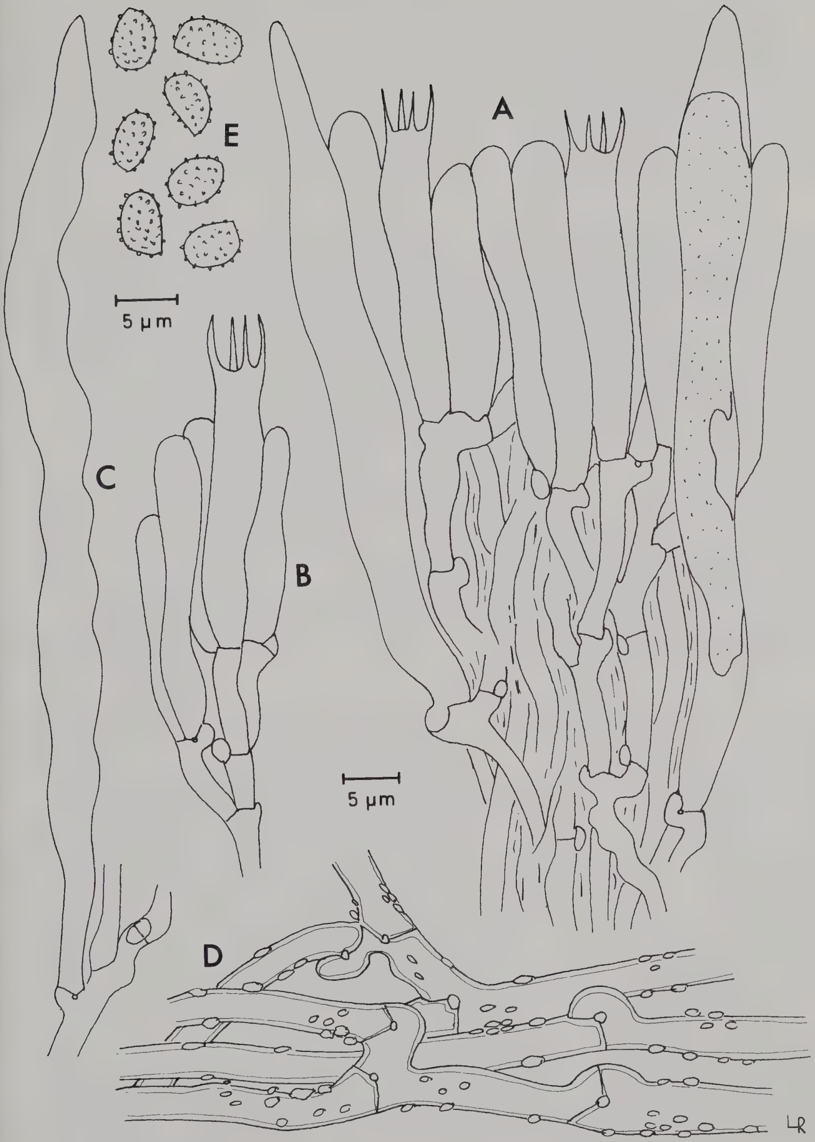
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Fig. 1. *Laxitextum incrustans*. a) section through the hymenium b) basidium c) gloeocystidium d) subicular hyphae e) spores. From the holotype.

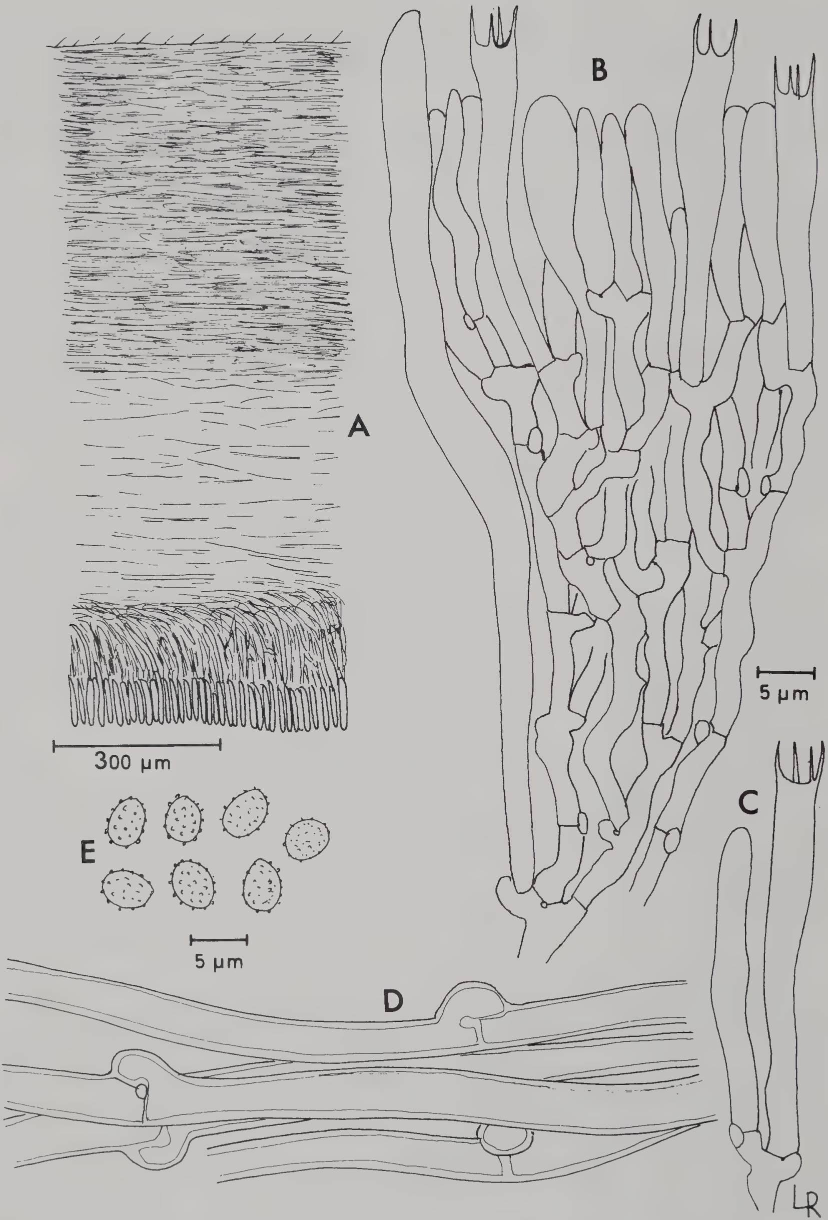
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Fig. 2. Laxitextum lutescens. a) section through the fruitbody b) section through the hymenium c) basidium d) subiculur hyphae e) spores. From the holotype.

species which also comes close to the group is Gloeocystidiellum furfuraceum (Bres.) Donk, but it lacks clamps.

We have also compared the new species with Scytinostromella humifaciens (Burt) Freeman & Petersen because of its somewhat similar spores and gloeocystidia. However, in that species the spores are smaller and the gloeocystidia react positively in benzaldehyde. Furthermore, like all species in Scytinostromella, also S. humifaciens, it is distinctly dimitic with skeletal hyphae.

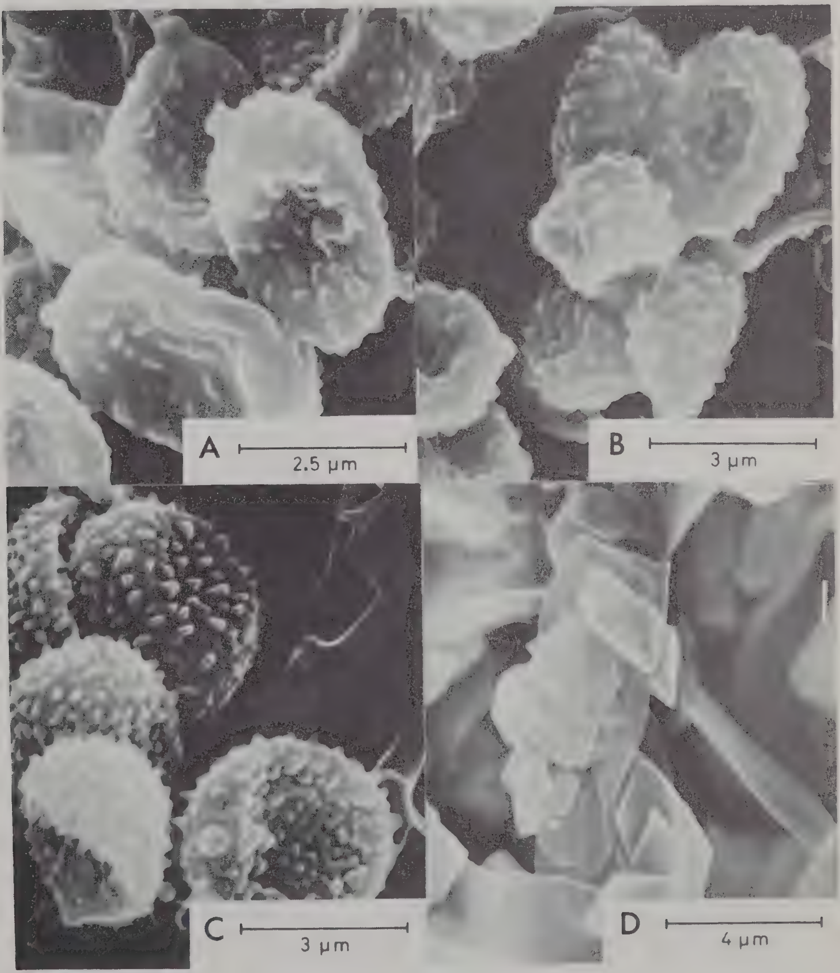

Fig.3. Spores of a) Laxitextum bicolor Coll. Ryv. 12092 b) L. lutescens, holotype c) L. incrustans, holotype d) encrusted hyphae from L. incrustans, holotype. SEM by L. Ryvarden.

LAXITEXTUM LUTESCENS Hjortst. & Ryv. nov. spec.
Fuctificatio resupinata vel distincta reflexa, 0.4-0.6 mm crassa, supra infuscata; tramate distincto evoluto, 0.4-0.5 mm crasso; hymenium leve, cremeum vel lutescens, leviter rimosum; systema hyphale monomiticum; hyphis cum fibulis, rectis, levibus, laxe intertextis, luteobrunneis, circiter 4 um latis; hyphis subhymenialibus irregularibus, hyalinis; gloeohyphae et gloeocystidia numerosa, amyloides; basidia anguste clavata, 20-25 x 7 um, 4 sterigmatibus; sporis subglobosis vel ellipsoidibus, echinulatis, 4 x 3-3.25 um, valde amyloidibus.

HOLOTYPUS: Africa. Ghana. Ashanti Region, Bobiri Forest Reserve, ab. 30 km E of Kumasi.18.-22. April 1974. L. Ryvarden 12875 (0).

Fruitbody resupinate to distinctly reflexed, 0.4-0.6 mm thick, pileus deep yellow to pale brown velutinate, azonate, trama well developed, pale yellowish brown, about 0.4-0.5 mm thick, hymenium cream-yellowish to strawcoloured with a light purple-brown tint, slightly cracked. Hyphal system monomitic, tramal hyphae loosely interwoven, pale yellowish brown, 3-5 um wide, smooth and with clamps. Subhymenial hyphae more irregular with the colour pale yellow or hyaline, mostly collapsed. Oleiferous hyphae abundant, 5-6 um wide, distinctly amyloid and with clamps at long intervals. Gloeocystidia numerous, arising from the tramal layer, fusiform, with the apex obtuse, now and then with schizopapilles, 90-120 x-7-9 um, sometimes up to 150-200 um or more, distinctly amyloid, but negative in benzaldehyde. Basidia narrowly clavate, 20-25 x 4 um, with four sterigmata. Spores subglobose to ellipsoid, echinulate, 4 x 3-3.25 um, strongly amyloid.

Remarks. Laxitextum lutescens seems to be well located in in the genus and is similar to L. bicolor, but delimited by its deep yellowish colour , the amyloid gloeocystidia and oleiferous hyphae and the shorter spores. The tramal hyphae of L. bicolor are besides more distinctly brown.

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NOTES ON *ZOOPHTHORA OCCIDENTALIS* (THAXTER) BATKO (ENTOMOPHTHORALES: ENTOMOPHTHORACEAE)[1]

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INTRODUCTION

The species *Entomophthora occidentalis* (Thaxter) 1888 was described by Thaxter (1888) as a species of *Empusa*. He recorded this pathogen as frequently and commonly infecting aphids on *Betula populifolia* Marsh in Maine, U.S.A. Batko (1964b) renamed this species *Zoophthora occidentalis* (Thaxter) and then placed it in the subgenus *Zoophthora* Batko (1966b) which includes the group of species referred to as the "*Entomophthora sphaerosperma* group" (Hutchison 1965; Waterhouse 1975; Remaudière et al 1976; Zimmermann 1978) and recently defined as *Zoophthora* Batko *sensu stricto* (Remaudière and Hennebert 1980).

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Further notes on the occurence of this species are scarce and data on its morphology constitute only abbreviated records of the original description. Since the systematics of species within the subgenus *Zoophthora* has not yet been thoroughly defined and because the biology and morphological characteristics of *Zoophthora phalloides* Batko (1966a) closely resemble those of *Z. occidentalis*, it is useful to present the results of our observations of these fungi in recent years.

MATERIALS AND METHODS

In August and September of 1977 in Orono, Maine, five entomophthoraceous species were discovered on aphids *Myzus persicae* Sulz. infesting potatoes: *Z. occidentalis*, *Erynia neoaphidis* (Remaudière) Batko, *Z. exitialis* (Hall and Dunn) Batko, *Conidiobolus thromboides* Drechsler (= *Entomophthora virulenta* Hall and Dunn), and *Entomophthora major* (Thaxter) Gustafsson. Of these, *Z. occidentalis* was predominant. This pathogen was also collected from *Aphis fabae* Scopoli on pigweed, *Chenopodium album* L. The strains of this species were examined in the laboratory with application of usual microscopic techniques and suitable methods of cultivation on egg yolk and Sabouraud's maltose agar (EYSMA) and potato-dextrose agar (PDA) in 16 hours photophase. Laboratory infections were also attempted using several aphid species and caterpillars of *Choristoneura fumiferana* Clem. with conidial showers of the fungus. On July 13, 1978, a morphologically similar strain was found in the Wielkopolski National Park, Poland, on an aphid of the tribe Macrosiphina from *Deschampsia caespitosa* (L.) P.B. in the forest undergrowth. These materials have been preserved as microscopic preparations in lactophenol with cotton blue (LPCB) and the strains from the USA also in living cultures on media. In the course of the studies on the morphology and systematic position of these strains, a comparison was made with the holotype of *Zoophthora phalloides*, and data on the paratypes of this species were obtained.

RESULTS

A. Morphology and Diagnostics. The infected aphids produced rhizoids (Fig. 1) from the abdominal part of their bodies as 1-3 compact bundles which firmly attached them to plant leaves. The tips of the hyphae forming these rhizoidal bundles are widened and deeply sinuate (Fig. 1a).

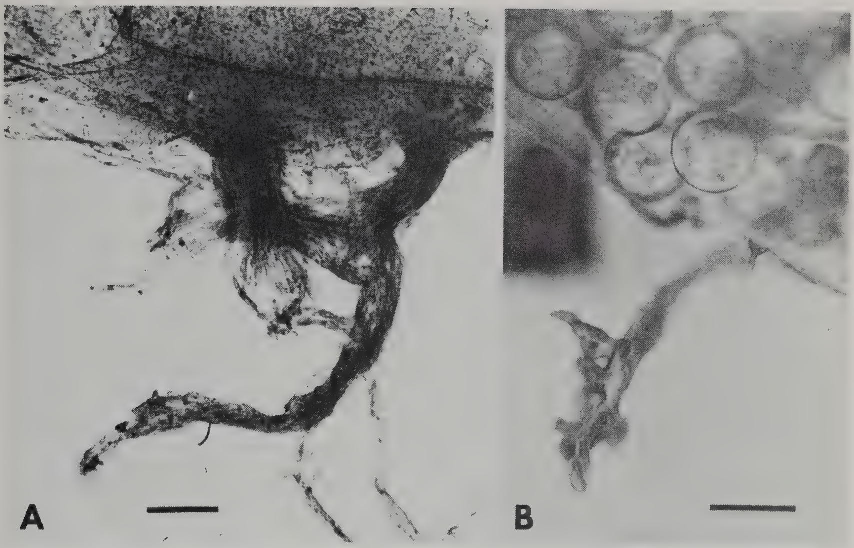

FIG. 1. Rhizoids of Z. *occidentalis* from hosts producing (a) conidia and (b) resting spores. Bar = (a) 20µ, (b) 10µ.

During the time of sporulation, the conidiophores covered the bodies with a compact mass of silver-white to white-cream mycelium; on the aphid from *D. caespitosa* the color of the mycelium was dirty lily. Pseudocystidia tapered with slightly blunt tips are scarce, and not a constant feature in the microstructure.

The conidia (Fig. 2) are elongated, with sides bowed slightly outward; conidia may be slightly curved. The conidium narrows slightly towards the papilla, and has a bluntly conical apex. In outline, the papilla is triangular, and often bears a small central apiculus or archwise and obtuse. The single nucleus is oval or elongate, and strains well in LPCB; the plasma appears somewhat hyaline with several granules. Dimensions of the conidia from aphids or from media differed remarkably: From aphids, they were found to be 25-26:5µ X 8-10µ (av. 30 X 9µ), L/D 2:3-3:5 (av. 3.0). From EYSMA conidia were 24-42µ X 7-10µ (av. 31 X 9µ); L/D 3:4-4:5 (av. 4.0). Secondary conidia of the first order are similar to the primary ones but a little shorter.

After the transfer of the conidia from EYSMA to PDA, capillispores are formed in great numbers, and a few secondary conidia of further orders usually appear; these

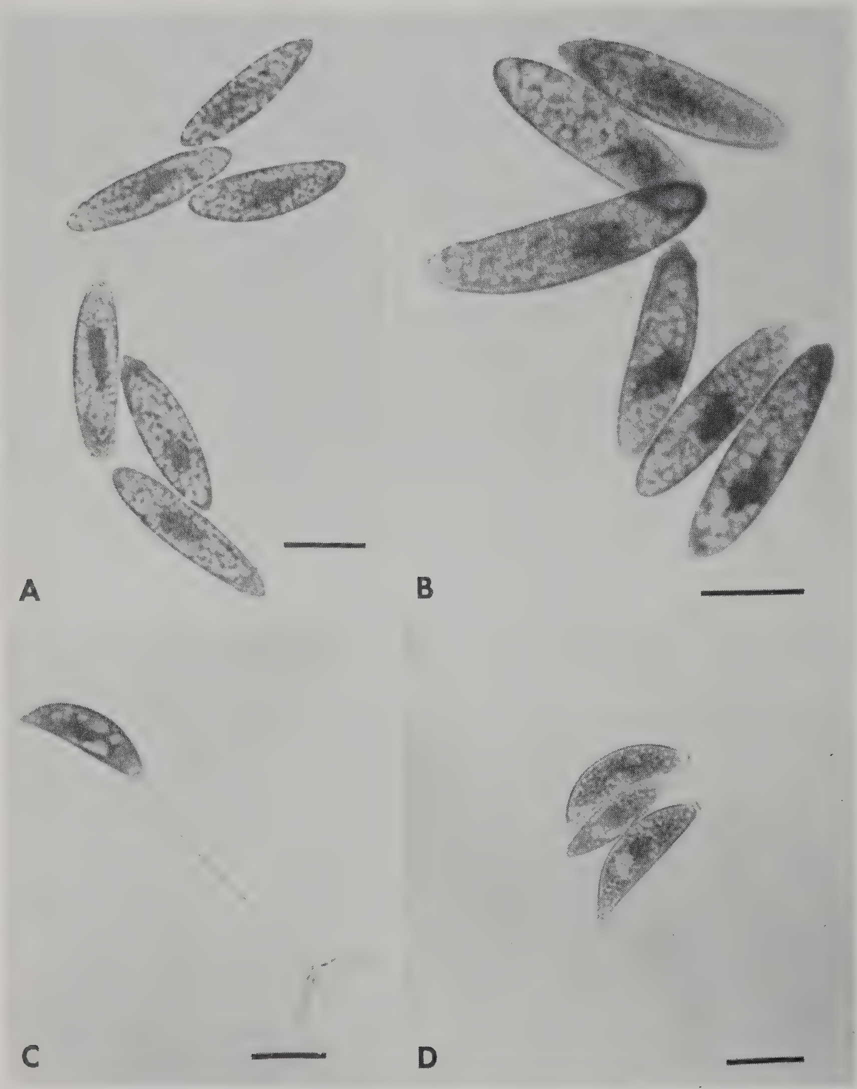

FIG. 2. Primary conidia of Z. *occidentalis* (a, b) are elongate and slightly curved. Primary conidia may produce secondary capillispores at the end of a fine tube (c); these secondary conidia are more strongly curved than primary conidia and lack a definite papilla (d). Bar = 10μ.

latter conidia are short and considerably different from the primary, with L/D ratio less than 2. Capillispores (Fig. 2c,d) are found relatively seldom on aphids. Capillispores from aphids were found to be 20.2-25.1 X 7-9μ, and, from media (EYSMA after transfer to PDA), 22-33.3 X 7-9μ; L/D 2:6-3:7 (av. 3:2).

Resting spores (Fig. 3) were formed in artifically infected aphids or on EYSMA at the temperature 25-27°C. They are smooth, globose, (20.5) 24-30 (32.5)μ diameter, with a light yellow wall 5-6μ thick. On EYSMA at 25-27°C, resting spores were larger (20-41.5μ) than in the insect. On the basis of many observations of early starges of spore development, it is concluded that resting spores are formed both as azygospores and zygospores, even though the "classical" types of conjuation noted and illustrated by Thaxter (1888, p. 171-172) were not observed.

Misidentification of *Z. occidentalis* and *Z. phalloides* is possible because of the similarities of their published spore dimensions and, more importantly because of imprecise characterizations of the conidial apex in the description of these species. Thaxter (1888, p. 171) described the apex of *Z. occidentalis* as "tapering strongly" whereas Batko (1966a, p. 10-11) referred to *Z. phalloides* as "sharply pointed". On the basis of the analysis of differences described by Remaudière et al. (1976), studies which did not consider *Z. occidentalis*, the authors intended to provide a diagnosis for *Z. phalloides*. However, the comparison of the conidia of both species shows that the following alternatives would be more suitable:

- conidia cylindrical with parallel sides in outline, hemispherically convex papilla and broadly obtuse ends . . . . *Z. phalloides*
- conidia ellipsoidally spindle-shaped with the sides a little convex, papilla widely conical or slightly convex often with small sharp central apiculus, top part of the spore tapering with somewhat blunt apex . . . . . *Z. occidentalis*

B. Biology and Occurance. *Zoophthora occidentalis* was the most frequent pathogen among entomophthoraceous fungi collected from the aphid *M. persicae* in Orono, Maine, causing 70-80% among the cases of mycosis; whereas the

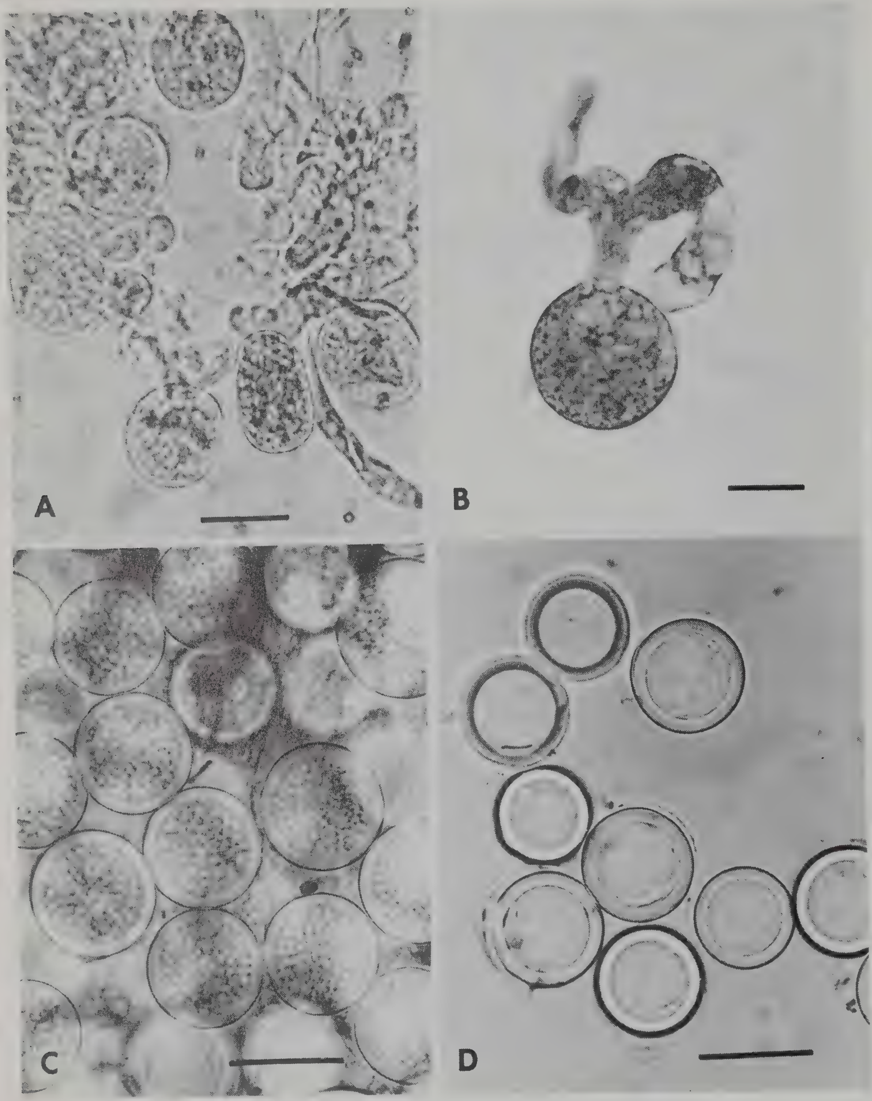

FIG. 3. Resting spores of Z. *occidentalis* are (a) thin walled in the early stages of formation and may be zygospores (b); the resting spore contents are granular at first (c) but contain an oil globule at maturity (d). Bar = (a,c,d) 20μ, (b) 10μ.

total mortality caused by entomogenous fungi was very high at the end of the growing season. On the media used in this investigation, the fungus grew and developed well, and produced all forms of spores. Under laboratory conditions, some species of potato aphids - viz., *M. persicae, Macrosiphum euphorbiae* Thom., *Aphis nasturtii* Kalt., and *Acyrtosiphon solani* Kalt. - were successfully infected with the spores produced on EYSMA. Attempts at similar infection against larvae of spruce budworm, *C. fumiferana*, failed.

The relative absence of *Z. occidentalis* from published reports probably derived form its misidentification as *Z. radicans* (Brefeld) Batko (= *Entomophthora sphaerosperma* Fres.). Even the investigations of Shands et al. (1958; 1962; 1963; 1972) on the entomogenous fungi of potato aphids in Maine, carried out between 1952-1972, did not report the presence of *Z. occidentalis.* Likewise, Gustafsson (1965) does not mention it from Sweden. Petch (1939; 1944) on the other hand reported it from two localities in Great Britain but contrary to his usual procedure offered no precise description. Batko (1962) listed it among Polish Entomophthoraceae from an aphid on nettle, *Urtica dioica* L., in the Bialowieza National Park, where, despite many repeated thorough searches, this species was found on few aphids only in one locality. Thus it may be interesting to determine the circumstances in which the increase of its frequency in natural conditions occurs, as well as to continue attempts to experimental infections in biological control of aphids.

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NEW CICADA PATHOGENS: *MASSOSPORA CICADETTAE* FROM AUSTRALIA AND *MASSOSPORA PAHARIAE* FROM AFGHANISTAN[1]

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INTRODUCTION

The genus *Massospora* was described by Peck (1879) and emended by Soper (1974). Forbes (1888) and Thaxter (1888) working independently, correctly placed this genus in the Entomophthoraceae. Species of *Massospora* are pathogenic to cicadas and thus far are found only in adults. These fungi attack the reproductive organs of their host. As the fungus grows, the terminal abdominal segments of the host slough off revealing either conidia or resting spores. Both stages do not normally occur in the same individual. The infected cicadas remain alive and take an active part in transmission of conidia to other adult cicadas or in distribution of the resting spores (Soper et al. 1976a). Only one species, *Massospora levispora* Soper, has received extensive epizootiological study (Soper et al. 1976b). From this investigation and the observations of White et al. (1979) on

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Massospora cicadina Peck, it is apparent that these pathogens play an important role in the population dynamics of their hosts.

Except for one report of *Massospora*, probably erroneously identified as *M. cicadina*, from the Japanese cicada *Platypleura kaempferi* F. (Kobayasi 1951), these fungi were known only in the Western Hemisphere. This paper describes two new *Massospora* species which indicates a much wider distribution by the addition of Afghanistan and Australian localities. This brings the total of known *Massospora* species to 13.

MASSOSPORA CICADETTAE Soper, sp. nov.

CONIDIA ochroleuca in massa, ellipsoideis, papilla indistincta, parietibus laevibus, 7.3-9.8 x 20.7-28.1 µm (9.0 ± 0.8 x 24.7 ± 2.1 µm, $\bar{x} \pm s$) binucleata vel interdum trinucleata vel uninucleata, nucleis nunquam bipolaribus autem ad partem latissimum conidii locatis. SPORAE PERDURES pallida vitellina in massa, reticulis profundis cameras distinctas formantes, cristis angustis laevibus vel raro minute papillatis, 26.8 - 38.7 µm in diam. (35.2 ± 3.2 µm, $\bar{x} \pm s$).

CONIDIA pale brownish yellow in mass, ellipsoid, with an indistinct papilla, smooth-walled, 7.3 - 9.8 x 20.7 - 28.1 µm (9.0 ± 0.8 x 24.7 ± 2.1 µm, x ± s), binucleate or ocasionally tri- or uninucleate, nuclei located at the broadest part of the conidium, never bipolar. RESTING SPORES pale egg-yolk yellow in mass, with deep reticulations forming distinct chambers, the narrow ridges smooth or rarely minutely papillate, 26.8 - 38.7 µm in diam. (35.2 ± 3.2 µm, $\bar{x} \pm s$). (Fig. 1)

Holotype: AUSTRALIA: New South Wales: 16 km east of Hay: Growing in the abdomen of an adult cicada, *Cicadetta murrayiensis* Distant, Det. M.S. Moulds. Conidial stage. 11 December 1978, *Coll. M.S. and B.J. Moulds.* CUP.

Paratypes: Same data as holotype. Resting spores present. CUP. AUSTRALIA: Queensland: Goomeri: near Kinbombi Falls. Growing in abdomen of *Cicadetta murrayiensis*, Det. M.S. Moulds. Resting spore stage present. 19 December 1976, *Coll. M.S. and B.J. Moulds.* CUP. Queensland: Aloomba: Growing in abdomen of *Cicadetta puer* (Walker), Det. K.J. Chandler. Conidial stage

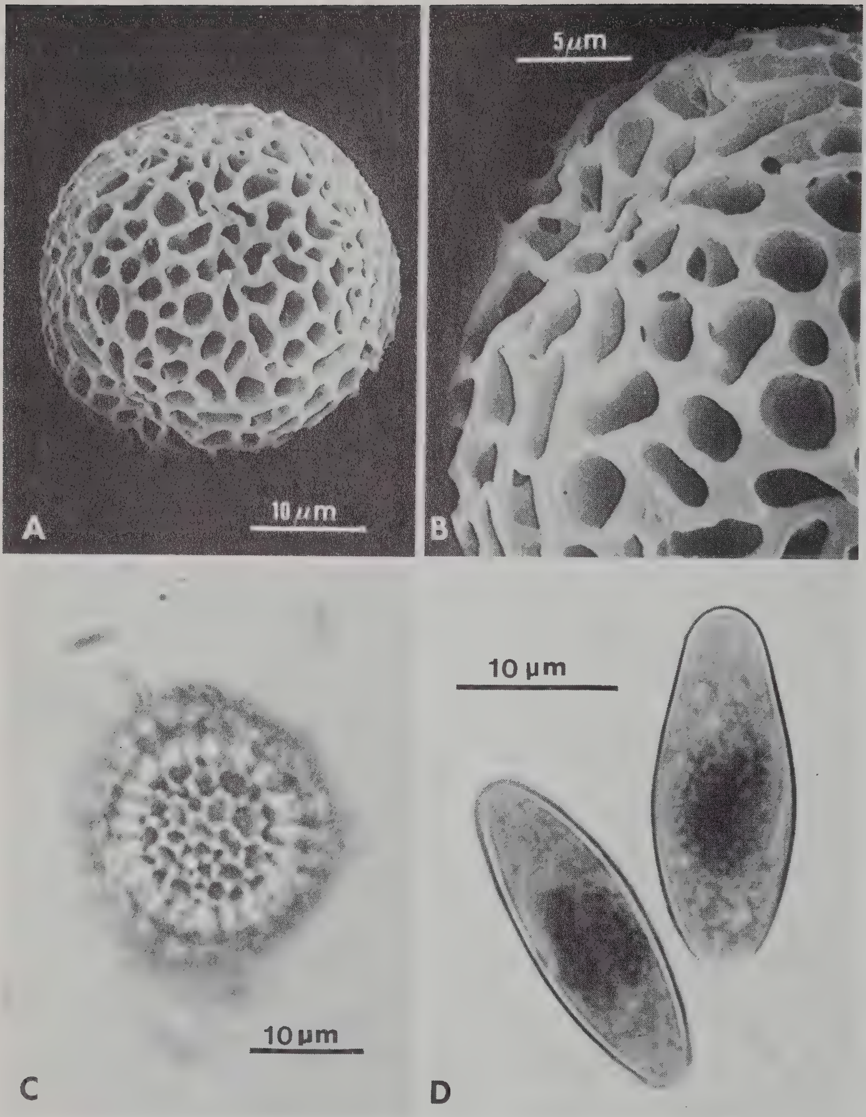
A
10 µm
B
5 µm
C
10 µm
D
10 µm

Figure 1. Spore stages of *M. cicadettae*: (A) and (B) scanning electron micrographs of resting spores; (C) resting spore as seen through light microscope; and (D) conidia.

present. 10 February 1973, *Coll. K.J. Chandler.* CUP. Tasmania: Davenport. Growing in the abdomen of *Cicadetta* sp., Conidia and resting spore stages present. No collection data. South Australia Museum.

Name: The species name of this *Massospora* is based on the generic name of its host, *Cicadetta.*

Host: Cicadetta murrayiensis, Cicadetta puer, and *Cicadetta* species (Cicadidae).

This species has the largest conidia yet described (9.0 x 24.7 µm) for *Massospora.* Although *Massospora dorisianae* Soper measure 10.8 x 21.8 µm thus approaching these dimensions, the spore surface is verruculose as opposed to smooth in *M. cicadettae.* The nuclei are distinctly bipolar in *M. dorisianae,* and although *M. cicadettae* is likewise generally binucleate, the nuclei are positioned centrally. The size and ornamentation of resting spores *(M. cicadettae)* are similar to the Chilean species *Massospora tettigatis* Soper which measures 36.3 µm in diameter. In the absence of conidial characteristics these species can be separated by the general lack of papillae on the reticulation of *M. cicadettae* resting spores as compared with numerous minute papillae found on *M. tettigatis* resting spores. The location (Australia) and host (*Cicadetta* sp.) are strong circumstantial support of *M. cicadettae* when only resting spores are present.

The host, *C. puer,* is a serious pest on sugar cane in northern Queensland, Australia. Although most cicadas have very long life cycles, viz., 4 to 17 years, *C. puer* is thought to complete its cycle in one year (K.J. Chandler personal communication). Potentially, *M. cicadettae* could have a correspondingly short life cycle, which would be the shortest known for any *Massospora* species. Intensive epizootiological studies on the periodical cicadas, *Magicicada spp.* indicate *M. cicadina* does not occur in the nymphal stages of the host nor in other genera of cicadas. This indicates *M. cicadina* must remain in the resting spore state for 17 years between the synchronized emergence of the adults (Soper et al. 1976a). A hiatus of 9 years between the occurence of *M. levispora* resting spore production in an isolated population of *Okanagana rimosa* (Say) was given as evidence of a correspondingly long survival of *M. levispora* (Soper et al.

1976b). These observations strongly suggest that the life cycles of *Massospora* species are controlled in some way by those of their hosts rather than by timing mechanisms intrinsic to the fungi themselves.

MASSOSPORA PAHARIAE Soper, sp. nov.

CONIDIA ignotae. SPORAE PERDURES cinnamomeae in massa, reticulis profundis irregularibus indistinctae, cameras indistinctas formantes, cristis late separatis angustis papillatis, 32.8 - 44.7 µm in diam. (39.5 ± 2.6 µm, $\bar{x} \pm s$).

CONIDIA unknown. RESTING SPORES dark red-brown in mass, with deep, irregular to indistinct reticulations, ridges widely separated, narrow, bearing numerous minute papillae, 32.8 - 44.7 µm in diam. (39.5 ± 2.6 µm, $\bar{x} \pm s$). (Fig. 2)

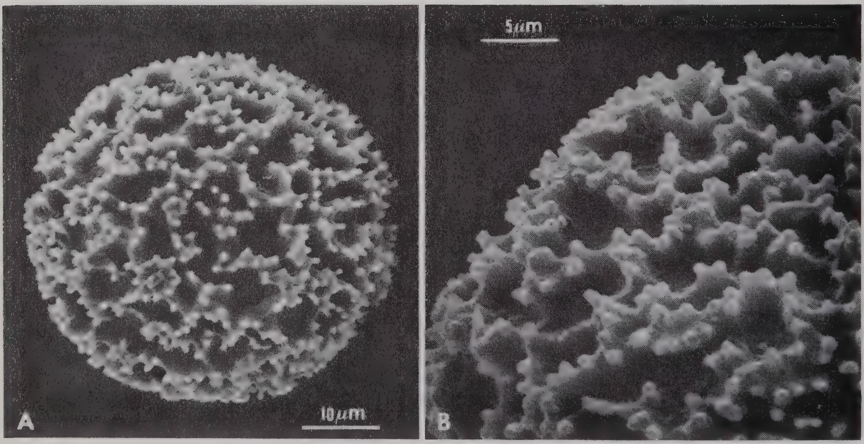

Figure 2. Scanning electron micrographs of *M. pahariae* resting spores, (A) and (B) note the many papillae on the reticulations.

Holotype: AFGHANISTAN: Paghman: Growing in the abdomen of an adult cicada, *Paharia casyapae* (Distant), collected on "shade and fruit trees", Det. R. Froeschner. Resting spores present. 3 July 1963, *Coll. E.R. Millet AF 4 63, 23-14756.* CUP.

Name: The species name of this *Massospora* is based on the generic name of its host, *Paharia.*

Host: Homoptera: *Paharia casyapae* (Cicadidae).

The resting spores of this species are similar to *Massospora levispora* Soper in their ornamentation (Soper, 1963, 1974). They can be differentiated by their average larger size 39.5 µm vs. 34.0 µm and fewer reticulations. In mass *M. levispora* resting spores are yellowish brown as opposed to the cinnamon brown of *M. phariae.*

SYNOPTIC KEY TO SPECIES

The following key is a revised version of the original (Soper 1974). To identify a species the key can be entered at any point. As additional characters are examined, a unique combination will be found for each species. If only the resting spore is present, it will be necessary to utilize scanning electron microscopy. Complete descriptions of species 1-11 are given by Soper (1974). Species numbers are underlined when the characteristic is unique.

1. *Massospora cicadina* Peck
2. *Massospora spinosa* Cifera, Machado & Vital
3. *Massospora levispora* Soper
4. *Massospora dorisianae* Soper[2]
5. *Massospora ocypetes* Soper
6. *Massospora tettigatis* Soper[2]
7. *Massospora carinetae* Soper[2]
8. *Massospora diminuta* Soper

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[2] Several orthographic errors were made in the original descriptions with respect to Latin endings. These have since been corrected in the Index of Fungi (1975. 4:312). The corrected spellings are used here.

9. *Massospora platypediae* Soper[2]
10. *Massospora diceroproctae* Soper[2]
11. *Massospora fidicinae* Soper[2]
12. *Massospora cicadettae* Soper
13. *Massospora pahariae* Soper

CONIDIAL CHARACTERS

1-1 *Conidial shape*

a. ellipsoidal 2,3,4,5,9, 10, 12
b. fusiform 10
c. globose 7
d. navicular 4
e. obovate 4, 10
f. ovoid 1, 2, 3, 5, 6, 11
g. subglobose 11, 7

1-2 *Number of nuclei*
a. one 3, 11, 12
b. two 1, 2, 3, 4, 6, 7, 9, 10, 12
c. three 3, 6, 12
d. four or more 6

1-3 *Conidial wall ornamentation*

a. absent 3, 6, 9, 12
b. verrucose 1, 2, 7
c. verruculose 4, 5, 10, 11

1-4 *Arrangement of nuclei*
a. bipolar 2, 4, 9, 10
b. random 1, 3, 6, 7, 12

1-5 *Conidial length*
a. less than 8 μm 9
b. 8 to 10 μm 2, 3, 5, 6, 7, 9
c. 10 to 15 μm 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
d. 15 to 20 μm 1, 2, 3, 4, 5, 6, 10
e. more than 20 μm 2, 3, 4, 10, 12

RESTING SPORE CHARACTERS

2-1 *Ornamentation of resting spore reticulum*
a. papillae absent 5
b. papillae minute 6
c. papillae rounded 1, 2, 3, 12, 13
d. papillae truncate 2, 8, 11

2-2 *Ridges of reticulum*
a. broad forming small chambers 6
b. irregular forming indistinct chambers 3, 13
c. narrow forming distinct chambers 1, 2, 5, 8, 11, 12

2-3 *Resting spore diameter*

a. less than 25 μm 8
b. 25 to 30 μm 3, 5, 6, 8, 12
c. 30 to 45 μm 1, 2, 3, 5, 6, 11, 12, 13
d. more than 45 μm 1

HOST

3-1 *Genus of cicada attacked*

a. *Carineta* 7
b. *Cicada?* 8
c. *Cicadetta* 12
d. *Diceroprocta* 10
e. *Dorisiana* 4, 5
f. *Fidicina* 11
g. *Magicicada* 1
h. *Okanagana* 3
i. *Paharia* 13
j. *Platypedia* 9
k. *Quesada* 2
l. *Tettigates* 6

DISTRIBUTION

4-1 *Collection localities*

Afghanistan 13
Argentina 5, 7
Australia 12
Brazil 2, 4, 7, 8
Honduras 11
Mexico 2, 9, 11
United States 1, 3, 9, 10
Venezuela 2

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LEOTIACEAE III. NOTES ON SELECTED TEMPERATE SPECIES REFERRED TO HELOTIUM AND HYMENOSCYPHUS

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SUMMARY

Fourteen temperate species of *Helotium* and *Hymenoscyphus* were studied and their taxonomic placement discussed. The accepted species are redescribed and illustrated. Of the fourteen, six were shown to be good species of *Hymenoscyphus*, four were demonstrated to be taxonomic synonyms of other species of *Hymenoscyphus*, one additional species is a probable synonym, and three were shown to be members of the Sclerotiniaceae.

As was recently pointed out by Carpenter (1981) and by Dumont (1980, 1981), the identification of the majority of the neotropical species of Inoperculate Discomycetes is difficult and, at times, frustrating due to the lack of comprehensive and updated monographs and floristic studies. Dumont (1980) pointed out, in his study of *Helotium rufo-corneum*, that even the most common species are still difficult to name correctly because of the lack of adequate literature descriptions and because of existing, confusing synonymies.

We have been attempting to work out the names of some of the more commonly encountered species of Inoperculate Discomycetes which we have collected (Carpenter & Dumont, 1978; Carpenter, 1981; Dumont & Carpenter, 1981; Dumont, 1980; and Haines, 1980) from neotropical regions. Dumont & Carpenter (1981) reported the difficulty they encountered while attempting to identify their own field collections of the *Helotium-Hymenoscyphus* complex and *Helotium*-like organisms from Colombia and adjacent regions and pointed out the need to reinvestigate all of the species of that genus described from the neotropics. Dumont (1981) presented a preliminary summary of all of the species of *Helotium-Hymenoscyphus* reported from the neotropics. In that study many species were actually excluded from the genus, placed into synonymy, or redistributed to genera in the Sclerotiniaceae.

While attempting to work out some of the complicated synonymies, such as found in *Helotium rufo-corneum*, it became necessary to study the literature and specimens of several species of temperate members of *Helotium-Hymenoscyphus*. The purpose in the paper is to present some of the information recently uncovered while studying the types of several temperate species described originally as *Helotium* or placed in *Helotium*, in hopes that this will add to the growing information on the genus *Hymenoscyphus*.

As I become more familiar with and study additional species of *Helotium-Hymenoscyphus*, I am beginning to see the emergence of two distinct groupings of species in the genus. One I refer to as the *Hymenoscyphus caudatus* group (which includes the type species *H. fructigenus*) and the second the *Hymenoscyphus epiphyllus* group. In the first group, the apothecia are stipitate, and the sterile tissue (outer ectal excipulum) from the base of the stipe to the margin is composed of a well developed and well defined textura porrecta to textura prismatica. In the *H. epiphyllus* group, the apothecia are generally turbinate to substipitate, and the outermost tissue of the stipe and frequently the lower portion of the receptacle adjoining the stipe is composed of a well to poorly defined textura globulosa to textura angularis. It is probable that these two distinct structural differences are worthy of recognition; either a separate genus for the *H. epiphyllus* group, or an infrageneric rank might be applicable. Since the majority of the species of *Helotium-Hymenoscyphus* still remain to be examined and redescribed, it would be premature to make additional modifications at this point.

The accompanying taxonomic key includes not only the species studied in the present work, but incorporates all of the species which I have previously studied (Dumont & Carpenter, 1981; and Dumont, 1980) and accept as valid species of *Hymenoscyphus*. The key should not be thought of as definitive, but one to which additional species should be added after they are studied. The methods used are the same as those reported by Dumont (1971).

Key to species of Hymenoscyphus studied

1. Apothecia subsessile, substipitate to turbinate; stipe (or substipe) and base of receptacle of apothecium to the outside composed of textura angularis or globulosa.........(*Hymenoscyphus epiphyllus* group)2.
    2. Ascospores 28-42x3-5μm, fusoid, anterior end pointed, posterior end attenuated.............................*H. dearnessii* p. 62.
    2. Ascospores less than 28μm long.................................3.
        3. Ascospores (7-)8-10(-12)x2.5-3.5(-4.5)μm, trapezoidal, obovoid, generally equilateral, if inequilateral then not flattened on one surface....................*H. immitabulis* p. 73.
        3. Ascospores more than 12μm long..............................4.
            4. Apothecia occurring on wood, strongly umbilicate; ascospores (13-)15-18(-20)x(3-)4-5μm............*H. umbilicatus* (See Dumont, 1980)
            4. Apothecia occurring on leaves, turbinate, not umbilicate; ascospores 15-18x3.5-5μm............*H. epiphyllus* p. 66. (See Dumont, 1980)
1. Apothecia stipitate; stipe (or substipe, if present) composed of textura porrecta to textura prismatica (if any globose cells present in stipe or receptacle, use first choice)...............................

....................................(*Hymenoscyphus caudatus* group)5.

5. Ascospores equilateral or if inequilateral then not flattened, generally trapezoidal to obovoid to obpyriform..................6.

6. Apothecia characteristically tiny, less than 1mm in diam, discoid; ascospores (10-)11-14(-15)x(3-)4(-5)μm on leaves; temperate..................................*H. translucens* p. 80.

6. Apothecia characteristically large, greater than 2mm in diam, irregular in outline, umbilicate; ascospores (4-)5-7(-9)x1.5-2(-2.5)μm......................................*H. leucopsis*
(See Dumont, 1980)

5. Ascospores strongly inequilateral, a high proportion flattened..7.

7. Ascospores with a large "nuclear staining area" visible in phloxine, cotton blue and analine blue dyes, rarely 1-septate, (22-)26-30(-35)x4-5(-6)μm, ascus apex papillate; tropical..*H. sclerogenus*
(See Dumont & Carpenter, 1981)

7. Ascospores without nuclear staining area...................8.

8. Ascospores regularly septate (more than 50% in any amount)..9.

9. Ascospores 1-septate, (17-)18-22(-24)x4-5(-6)μm; apothecia without hairs at the base of the stipe...*H. musicola*
(See Dumont, 1980)

9. Ascospores 3-septate, (20-)24-30(-35)x4-5(-6)μm; apothecia with hairs at the base of the stipe.......................................*H. lasiopodius*
(See Dumont & Carpenter, 1981)

8. Ascospores aseptate...................................10.

10. Ascospores (16-)18-22(-26)x2-3μm, with a basal cilium...*H. scutulus*
(See Dumont & Carpenter, 1981)

10. Ascospores without a basal cilium................11.

11. Ascospores hooked apically..................12.

12. Ascospores (16-)18-23(-30)x3-3.5(-4.5)μm, strongly and obviously hooked, tapering gradually to the base.........*H. serotinus*
(See Dumont & Carpenter, 1981)

12. Ascospores (14-)16-23(-26)x4-5(-6)μm, if hooked, only slightly and a few per mount, abruptly pointed at basal end...*H. caudatus*
(See Dumont & Carpenter, 1981)

11. Ascospores not hooked apically..............13.

13. Ascospores (11-)12-15(-16)x(2.5-)3-4μm, with internal, oily-resinous material...................................*H. cereus*
(See Dumont, 1980)

13. Ascospores without internal resinous, oily material.................................14.

14. Ascospores frequently curved and then indented, with anterior end pointed; apothecial margin with a gelatinous matrix present; ascospores (10-)12-16(-18)x3-4(-5)μm...*H. erraticus* p. 66.

14. Ascospores if curved, then not indented, with anterior end rounded; apothecial margin lacking a gelatinous matrix; ascospores (14-)16-23(-26)x4-5

(-6)µm..*H. caudatus*
(See Dumont & Carpenter, 1981)

1. *Helotium albopunctatum* Peck, Annual Rep. New York State Mus. 31: 47. 1879.

≡ *Hymenoscyphus albopunctatus* (Peck) Kuntze, Revis. gen. Pl. 3(3): 485. 1898.

NOTES. *Helotium albopunctatum* was described from New York by Peck (1879) as occurring on leaves, and was fully redescribed and illustrated by White (1943), who accepted its placement in *Helotium*. It was transferred to *Hymenoscyphus* by Kuntze (1898) and accepted in that genus by both Dennis (1964) and Arendholz (1979). After having studied the type deposited in NYS, I conclude that the species is the same as *Hymenoscyphus caudatus*, and I place it into synonymy and adopt the name *Hymenoscyphus caudatus* which has priority. This species fits well within my concept of *H. caudatus* as presented in Dumont & Carpenter (1981).

Holotype: U.S.A., New York Adirondack Mts., C. H. Peck (NYS, NY).

2. *Helotium caudatum* (Karsten) Velenovský, Monogr. Discom. Bohem. 1: 206. 1934.

≡ *Peziza caudata* Karsten, Fungi fenn. exs. 547. 1866.
≡ *Hymenoscyphus caudatus* (Karsten) Dennis, Persoonia 3: 76. 1964.

NOTES. *Helotium caudatum* was originally described by Karsten from a foliicolous collection made in Finland; it is a very common temperate and neotropical species. Dennis (1964), Arendholz (1979), and Dumont & Carpenter (1981) accept the species in *Hymenoscyphus*, a decision with which I concur. For a full description, illustrations, and discussion, see Dumont & Carpenter (1981).

3. *Helotium conocarpi* Seaver & Waterston, Mycologia 34: 517. 1942.

NOTES. *Helotium conocarpi* was originally described from Bermuda on leaves. It was accepted in *Helotium* by White (1943), but neither Dennis (1964) nor Arendholz (1979) treated the species. Dumont (1976) has shown the species to be a member of the genus *Moellerodiscus* (Sclerotiniaceae). See Dumont (1976) for full description, illustrations and discussion.

4. *Helotium dearnessii* (Ellis & Everhart) White, Mycologia 34: 167. 1942.
FIGS. 1, 2.

≡ *Phialea dearnessii* Ellis & Everhart, Proc. Adad. Nat. Sci. Philadelphia 1893: 146. 1894.
≡ *Hymenoscyphus dearnessii* (Ellis & Everhart) Kuntze, Revis. gen. Pl. 3(3): 485. 1898.

Apothecial morphology — Apothecia minute, scattered or found in small groups, subsessile, to ca 1mm in diam, ca 1mm high, when fresh disc drying concave, rehydrating convex. Hymenium when fresh at first subolivaceous,

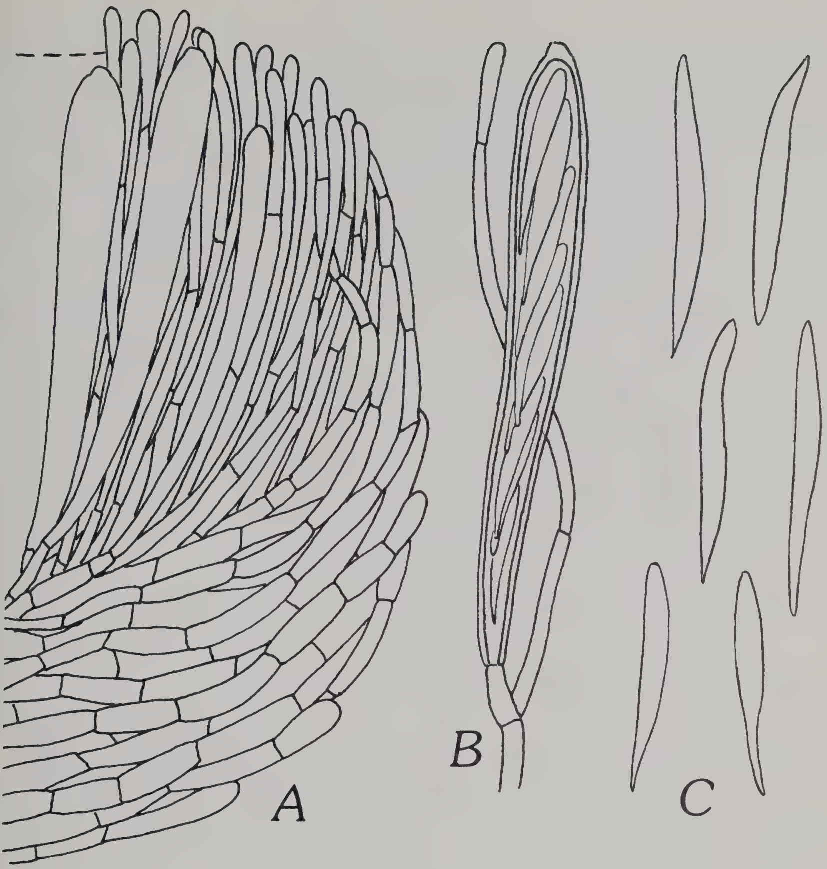


FIG. 1. *Hymenoscyphus dearnessii*, holotype ex NY, freehand drawings, x 1,000. A. Median longitudinal section of an apothecium through margin. B. An ascus and a paraphysis. C. 6 ascospores drawn after discharge from ascus.

becoming yellow, drying flesh-colored to ochraceous, rehydrating lighter and yellowish; receptacle generally concolorous with hymenium when fresh, dry and rehydrated; stipe coloration difficult to detect owing to small size, but appearing dark brown.

Apothecial anatomy — Asci 8-spored, 90-110x9-12µm, croziers reported by White to be absent, presence or absence uncertain owing to poor staining of the asci, but possibly present, long-cylindric to clavate, tapering towards the base and there generally not becoming expanded to form a small foot, walls ca 1µm thick, becoming enlarged at the subpapillate to papillate apex and there 3-4µm thick; pore J+, the pore walls staining intensely blue in Melzer's Reagent. Ascospores 28-42x3-5µm, details obscured in all collections owing to failure of spores to absorb stain ade-

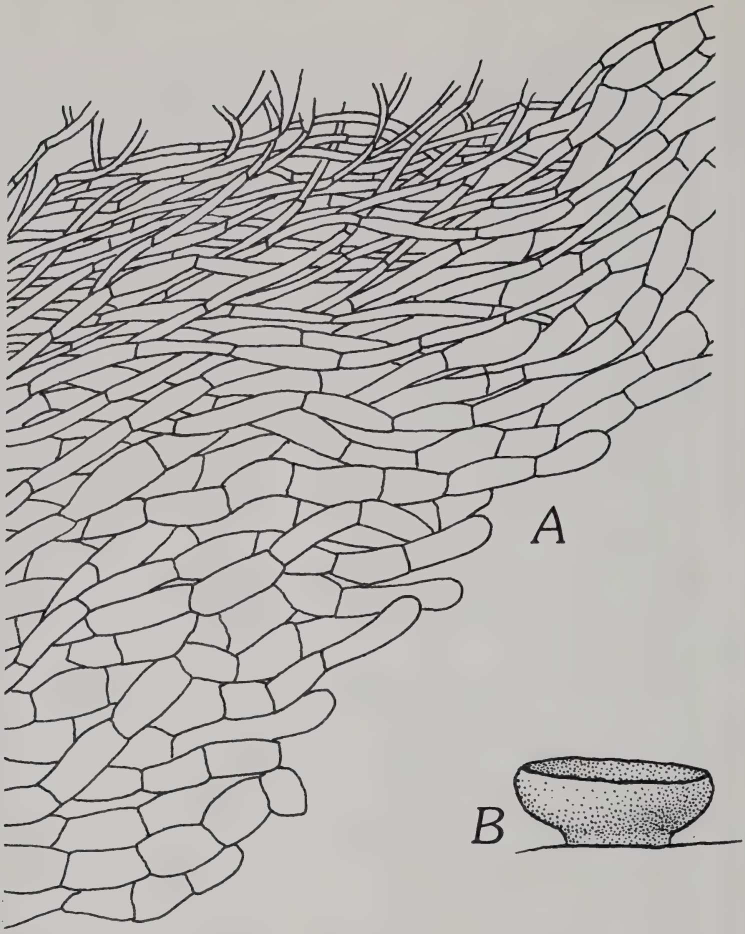


FIG. 2. *Hymenoscyphus dearnessii*, holotype ex NY, freehand drawings. A. Median longitudinal section of an apothecium at approximately juncture of stipe and receptacle, x 1,000. B. Habit sketch of an apothecium on the substrate, x ca 50.

quately, biseriate to irregularly uniseriate, hyaline, smooth, aseptate, elongate, fusoid, anterior end pointed, posterior end attenuated and drawn out to a fine point, a cilium reported by White not observed in these studies, in outline equilateral, frequently sigmoid and curved, guttules spherical to irregular in outline, irregularly dispersed in the individual ascospores and generally filling major portion of ascospores and separated by narrow bands of cytoplasm. Paraphyses equal to or slightly exceeding the asci, internally hyaline, occasionally branching towards the base of the asci, septate, filiform, becoming slightly expanded at the apex and there 2-4μm wide, walls thin, smooth and hyaline. Subhymenium absent, without a defined zone or differentiation of tissue beneath the asci. Medullary excipulum poorly developed, in the flanks consisting of narrow, parallel hyphae 2-3μm wide, in the center of the receptacle the parallel hyphae becoming torn apart and interwoven, the individual hyphae hyaline with walls thickened, refractive and smooth. Ectal excipulum: inner ectal excipulum absent. Outer ectal excipulum non-gelatinized, refractive due to thickened walls of hyphae, to ca 40µm wide towards the margin and to ca 60µm towards the stipe, consisting of hyphae originating in the stipe, and at the juncture of stipe and receptacle extending almost perpendicularly to the surface of the apothecium, continuing towards the margin the individual hyphae extending to the surface at gradually lower angles until at the margin the hyphae parallel to each other and to the surface of the apothecium, the individual cells brick-shaped, (6-)8-12 (-20)x4-8µm, the walls thickened, hyaline and smooth, at the surface of the apothecium the apically free cells unmodified and remaining appressed to the surface. Outer covering layer absent. Hairs absent. Margin narrow, consisting of hyphae originating in the receptacle and extending parallel to the surface, as described for the receptacle, but less refractive. Stipe to the outside composed of a pigmented zone of irregularly arranged hyphae, in some areas the individual hyphae losing hyphal orientation, and appearing cellular in composition, the individual cells brick-shaped, globose or angular, lightly to intensely pigmented, the walls thickened, non-gelatinized and obviously roughened; inside the pigmented zone, the hyphae narrow, 2-3µm wide, extending parallel to each other and to the surface of the apothecium and continuing into the medullary excipulum of the receptacle, the individual cells hyaline or pigmented light brown, the walls slightly thickened, lightly pigmented or hyaline and generally smooth. Hairs absent.

Habitat: On old stems of *Steironema ciliatum.*

Etymology of the specific epithet: refers to the collector of the original and type specimen.

Holotype: Canada, London, dead stems of *Monarda*, May 1980, J. Dearness 1713 (FH). See additional notes below.

Illustrations: White, Farlowia 1: 615, figs. 31-34. 1944. Dennis, Persoonia 3: 41, fig. 16. 1964.

NOTES. *Phialea dearnessii* was described by Ellis & Everhart from a collection made by J. Dearness (1713) in Canada. As White (1944) has pointed out the type collection was made in May 1890; and the host was originally described as *Monarda*, but Dearness apparently returned to the same locality in June and collected additional material of the new species and concluded that the host was not *Monarda*, but *Steironema ciliatum*. To add to the confusion, Dearness gave the new collection the same number as the original material, but fortunately they both do represent the same species.

Kuntze (1898) transferred *Phialea dearnessii* to *Hymenoscyphus*; White (1944) placed it in *Helotium*. Dennis (1964) accepted its placement in *Hymenoscyphus*, a decision with which I concur. The species appears to be most clearly related to other substipitate species in the genus, such as *H. epiphyllus*. In these species the stipe is composed of hyphae which do not form a well-structured textura prismatica or porrecta, as in species such as *Hymenoscyphus caudatus* and its related species, but the hyphae become disoriented with the individual cells losing hyphal orientation and also losing the layered effect. In *H. epiphyllus*, *H. immutible* and *Helotium midlan-*

dense the outermost tissue of the stipe toward the receptacle is formed of textura globulosa to textura angularis. Further, in these species, the ectal excipulum towards the stipe is formed of hyphae originating in the interior of the stipe and extending nearly perpendicularly or at very high angles to the surface of the apothecium. From the stipe to the margin, the hyphae approach the surface at lower angles until at the margin the hyphae are parallel to the surface. In the *H. caudatus* group the ectal excipulum is formed of hyphae originating in the stipe and running parallel (or at a very low angle) to the surface from the stipe to the margin. *Hymenoscyphus dearnessii* is separated from these other species by the size of its ascospores.

White (1944), in his description of *H. dearnessii*, mentioned that the ascospores produced a delicate cilium 2.5-3.5 µm long. In the portion of the type which I studied, the ascospores only poorly absorbed the various stains utilized; and, for this reason, I was unable to observe certain features of the anatomy of the species. I did not observe the cilium described by White, but agree with him that the ascospores do become obviously attenuated.

5. *Helotium epiphyllum* (Persoon ex Persoon) Fr., Summa veg. Scand. p. 356. 1849.

≡ *Peziza epiphylla* Persoon, Ann. Bot. (Usteri) 11: 30. 1794.
≡ *Peziza epiphylla* Persoon, Mycol. Europ. 1: 295. 1822.
≡ *Hymenoscyphus epiphyllus* (Persoon ex Persoon) Rehm ex Kaufmann, Pap. Mich. Acad. Sci. 9: 177. 1929.

NOTES. *Helotium epiphyllum* is a very widely distributed species in temperate regions. As mentioned by Dumont (1981), the presumed type of *Hymenoscyphus epiphyllus* deposited at L contains only sclerotia of an unidentified fungus. Until the situation of the type of the species is resolved, I am following the concept of the species as set forth by Dennis (1956) and Arendholz (1979), both of whom illustrate the species. Dumont (1981) has fully described and illustrated a tropical variant of the species.

6. *Helotium erraticum* White, Farlowia 1: 606. 1944. FIG. 3.

Apothecial morphology — Apothecia scattered or rarely gregarious, generally produced from leaf blades, small, stipitate, 0.5-1.0mm in diam, to ca 1.0mm high, when fresh cupulate in youth, disc flat with age. Hymenium when fresh white to off-white, drying bright yellow, dull yellow, ochraceous, or rarely reddish; rehydrating translucent, pallid to yellow; margin generally concolorous with margin when fresh, dry and rehydrated; receptacle when fresh white, drying slightly lighter than hymenium or concolorous, yellow to occasionally reddish, rehydrating as hymenium or slightly lighter; stipe generally concolorous with the receptacle when fresh, dry or rehydrated.

Apothecial anatomy — Asci 8-spored, 85-110x8-11µm, produced from small replicating croziers, broadly cylindric to long cylindric-clavate, tapering to the base and there becoming slightly expanded to form a small foot, wall to ca 1µm thick, enlarged to 2-3µm at the rounded to truncate apex;

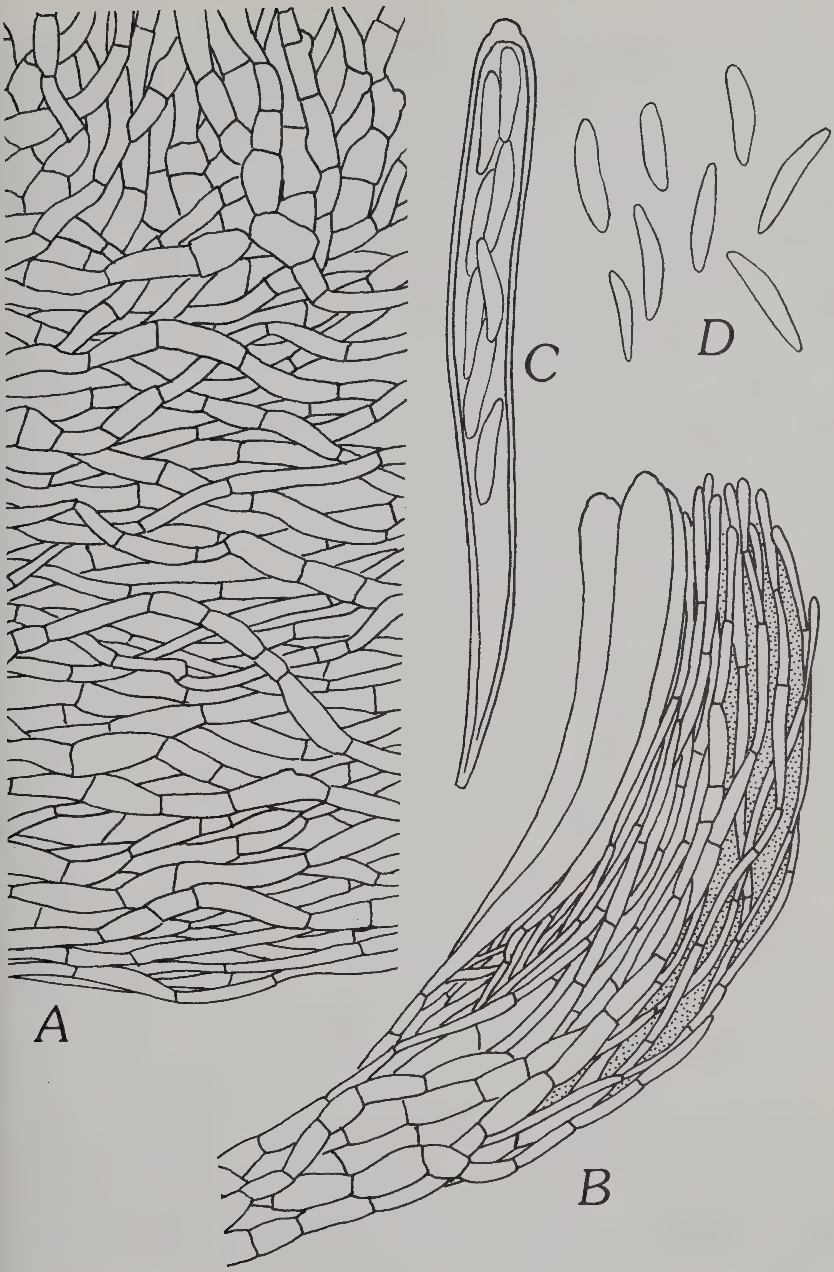


FIG. 3. *Hymenoscyphus erraticus*, freehand drawings, x 1,000. A. Median longitudinal section through an apothecium at approximately midpoint between stipe and margin. B. Median longitudinal section of an apothecium through margin. C. Ascus with 8 ascospores. D. 8 ascospores drawn after discharge from ascus.

pore J+ in Melzer's Reagent. Ascospores (10-)12-16(-18)x3-4(-5)µm, biseriate above and uniseriate below, biseriate throughout or less commonly obliquely uniseriate, hyaline, smooth, aseptate or rarely 1-septate (and then apparently in poorly preserved material), oblong, obovoid, ends rounded to pointed, in outline inequilateral, flattened on one side and generally curved and then slipper-shaped, generally anterior end slightly broader than posterior end, guttules present, more or less equal, irregular in outline, bipolar, filling about half the spore at each end. Paraphyses equal to or rarely slightly exceeding the asci, rarely branched near the base of the asci, sparingly septate, internally hyaline, filiform, becoming slightly expanded at the apex and there 2-4µm wide, walls thin, hyaline and smooth. Subhymenium not well differentiated from the medullary excipulum, with a perpendicularly oriented zone to ca 40µm in the center staining more intensely than the remainder of the receptacle and composed of parallel, short, broad hyphae and croziers, the individual cells 2-4(-5)µm wide, the walls thin, hyaline and smooth, these hyphae tightly compact and grading into the upper portion of the medullary excipulum. Medullary excipulum poorly to well developed, hyaline, obconical, non-refractive, consisting in the center of loosely interwoven, branched, septate hyphae, towards the flank and subhymenium becoming more lightly compact and parallel to subparallel, the individual hyphae 2-5µm broad, the walls thin, hyaline and smooth. Ectal excipulum not divided into recognizable layers, to the outside the hyphae more tightly compact and narrower than the hyphae in the center of the excipulum; in this region forming a well developed textura porrecta to prismatica, the individual hyphae hyaline, the walls thickened, hyaline and smooth; these hyphae grading toward and into the narrow hyphae of the medullary excipulum. Margin at its base constructed as the upper portion of the flanks, but soon becoming characteristically gelatinized, the spaces between the individual hyphae 1-2(-3)µm, the apical cells unmodified. Stipe composed as the flanks, the individual hyphae larger than comparable cells in the flanks. Hairs absent from the margin, flanks, and stipe.

Habitat: On leaf blades of unidentified species, leaves of *Amelanchier* sp., *Ulmus* sp., *Hamamelis* sp. and *Populus* sp., and last year's pods of *Robinia pseudo-acacia*.

Etymology of the specific epithet: relevance to the fungus uncertain.

Holotype: U.S.A., New York, Coy Glen, near Ithaca, on decaying leaves, 3 Oct 1938, H. H. Whetzel & W. L. White s.n. (White herb nos. 3421 and 3416, one collection apparently divided into two packets or two specimens collected on the same day with identical data.)

Paratype specimens: U.S.A., New York, Malloryville, W. of North Bog, on leaves of *Amelanchier* sp., *Ulmus* sp., and *Hamamelis* sp., 18 Oct 1941, H. H. Whetzel & Niederhauser s.n. (FH ex CUP 29658); Newfield Gorge, Ithaca, last year's pods of *Robinia pseudo-acacia*, 26 Oct 1941, H. H. Whetzel & T. Sproston s.n. (FH ex CUP 29666); Canada, Quebec, Duchesnay, County Portneuf, on leaves of *Populus* sp., 25 Aug 1938, H. H. Whetzel & T. Sproston s.n. (FH ex CUP 27850).

Illustrations: White, Farlowia 1: 607, figs. 14-18. 1944. Arendholz, Morphologisch-taxonomische Untersuchengen an blattbewohenden Ascomyceten aus der Ordnung der Helotiales, pl. 15, fig. 4. 1979.

NOTES. *Helotium erraticum* was described by White (1944) who indicated that the species was closely related to members of the *Helotium epiphyllum* group: *H. epiphyllum* *H. immuta-*

bile, *H. carpinacola*, and *H. midlandense*. These latter four share in common one feature which is absent in *H. erraticum*. In all four the ectal excipulum at the juncture of the receptacle and stipe is composed of globose cells to the outside, with hyphae progressing gradually from high angles to the surface in the lower portion to parallel at the margin. I have found no globose cells in any of the collections studied here of *H. erraticum*.

I conclude that *H. erraticum* is closely related to *Hymenoscyphus caudatus*. In *Helotium erraticum* the ascospores are generally curved and frequently indented or slipper-shaped, while in *Hymenoscyphus caudatus* the ascospores are inequilateral and generally not curved and when curved, not slipper-shaped. A high proportion of the ascospores in *Helotium erraticum* have ascospores with pointed apices, while this feature is absent in *Hymenoscyphus caudatus*. In *H. caudatus* the margin is composed of thin-walled, brick-shaped cells, while in *Helotium erraticum* the margin is unusual for a member of *Hymenoscyphus*. The margin is composed of narrow cells apparently imbedded in a gelatinous matrix; at times, however, the hyphae are tightly compact, and it is difficult to interpret the structure, and the walls merely appear thickened. In one collection (CUP 29666) the hyphae in the ectal excipulum are narrower than normal and very thick-walled, and the ascospores are 1-septate. The collection appears to be badly preserved, which may account for the abnormal formation of the sterile tissue and the septation in the ascospores. All other features are characteristic for *Helotium erraticum*. The shape and size is right for the species, as is the characteristic subhymenium. I conclude that this is merely a variant collection.

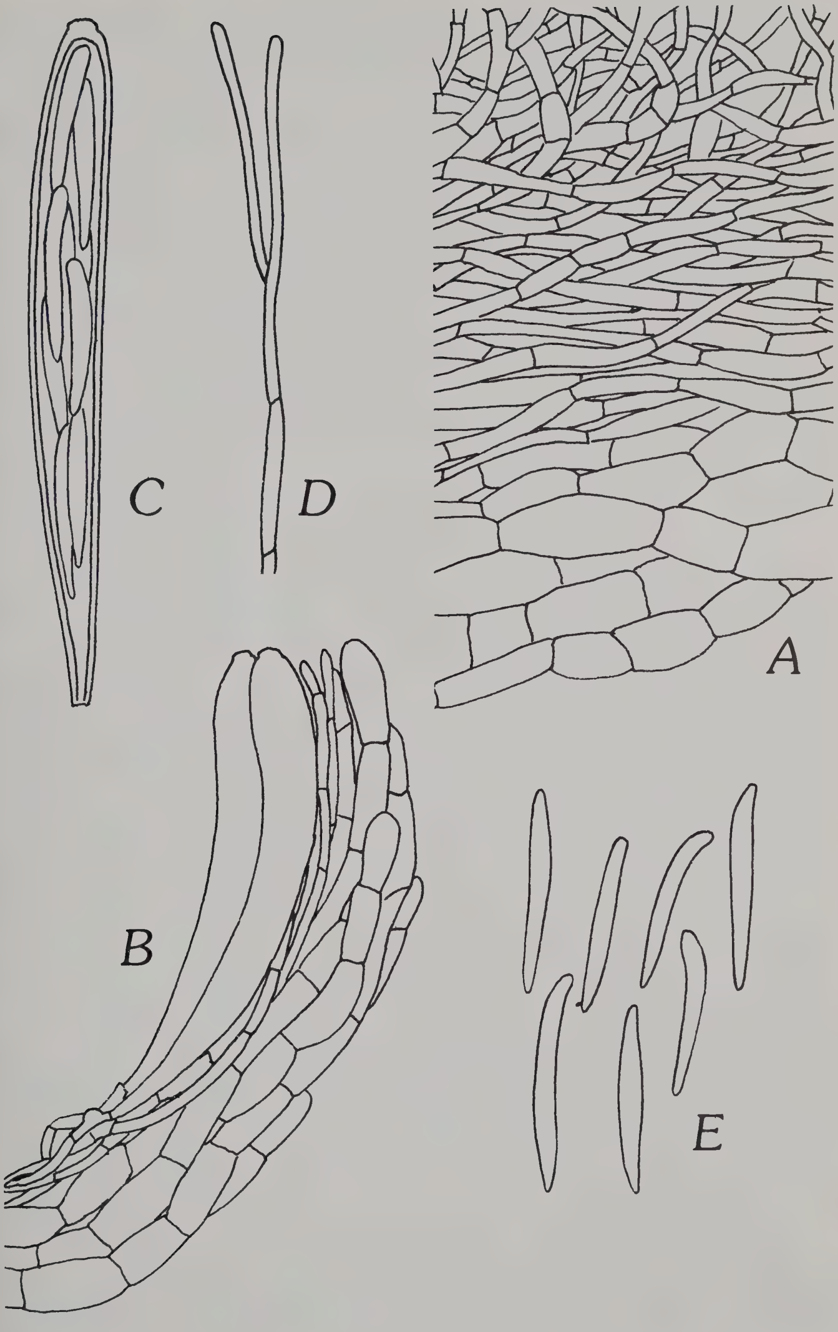
I am somewhat concerned about the placement of this species in *Hymenoscyphus*, since it produces a margin with at least some hyphae in a gelatinous matrix. This feature is more characteristic of the genus *Crocicreas* than it is of *Hymenoscyphus*. However, the ectal excipulum is that of an *Hymenoscyphus*. Dennis (1964) did not treat the species, while Arendholz (1979) did place it in *Hymenoscyphus* as *H. erraticus*. I conclude that the species is perhaps intermediate between the two, but shows more affinities to *Hymenoscyphus* than to *Crocicreas*. I will, thus maintain it in *Hymenoscyphus*.

7. *Helotium fastidiosum* Peck, Annual Rep. New York State Mus. 27: 107. 1875. FIG. 4.

Apothecial morphology — Apothecia scattered, stipitate, 1-1.5mm in diam, 1-1.5(-3)mm high, when fresh disc flat, drying flat to slightly cupulate, rehydrating convex. Hymenium when fresh off-white to pale yellow, drying darker, yellow, ochraceous to flesh-colored, rehydrating lighter, slightly translucent; receptacle when fresh generally slightly darker than hymenium and white to dark yellow, drying and rehydrating darker than hymenium; stipe narrow, cylindrical, when fresh above concolorous with the lower portion of the receptacle, becoming darker toward the base, drying darker, especially toward the base, or rehydrating lighter and pallid, darker below.

Apothecial anatomy — Asci 8-spored, (75-)85-100x9-12µm, produced from small croziers, long cylindric-clavate, tapering gradually to the base and there occasionally becoming slightly expanded to form a small foot, wall to ca 1µm thick, enlarged at the papillate apex and there 2-3µm thick; pore J+, visible as two, dark blue apical dots in Melzer's Reagent. Ascospores (23-)26-30(-35)x2.5-3.5(-4.5)µm, obliquely uniseriate to irregularly arranged, hyaline, smooth, aseptate, subfusoid to clavate, apical end hooked and pointed, basal end pointed, in outline inequilateral, curved and rounded in the upper portion, flattened and straight below, anterior end broader than posterior, with a single row of spherical to irregular guttules filling majority of the spores. Paraphyses equal to or slightly exceeding the asci by 5µm, internally hyaline and devoid of pigmented contents, branching occasionally toward the base of the asci, septate, filiform, not expanded at the apex and there 2-3µm wide, walls thin, smooth and hyaline. Subhymenium not well differentiated from the medullary excipulum, poorly developed, with an indistinct hyaline zone beneath the asci with hyphae more tightly compact than the medullary excipulum below. Medullary excipulum poorly developed in the flanks and in the center of the apothecium, hyaline, non-refractive, consisting of septate, branched, vertically oriented to tightly interwoven hyphae 3-6µm wide, the walls thin, hyaline and smooth. Ectal excipulum: inner ectal excipulum well defined and well differentiated from the outer ectal excipulum and grading into the medullary excipulum, entire layer hyaline, non-refractive, to ca 10µm wide toward the margin and to 25µm toward the stipe, consisting of tightly compact, hyaline hyphae 2-4µm wide, with walls thin, non-refractive, hyaline and smooth. Outer ectal excipulum non-gelatinized, non-refractive or rarely appearing slightly refractive due to thickened walls, to ca 20µm broad toward the margin and to ca 30µm toward the stipe, consisting predominantly of a well defined textura prismatica with the individual hyphae extending parallel to the surface of the apothecium and without apically free hyphal tips; the individual cells toward the margin 8-15x4-8µm, 12-25x5-8µm toward the stipe, the walls thin or rarely slightly thickened, hyaline and smooth. Outer covering layer present or becoming detached and the apothecium then appearing naked, consisting of 1-2 layers 2-5µm broad, the individual hyphae extending parallel to the surface, overlapping, terminating before the margin, the apically free cells remaining appressed to the surface of the apothecium and unmodified, the individual cells hyaline or rarely light yellow-brown, the walls non-refractive, hyaline to light brown, and smooth. Hairs absent. Margin generally poorly developed, narrow above, broader below, entire zone hyaline or light brown, constructed similarly to the receptacle below, the individual cells approximately same size as upper receptacle or slightly smaller, apical cells unmodified. Stipe in the upper portion constructed similarly to the lower portion of the receptacle and apothecial flank, at approximately midpoint and to the outside 1-2 layers of narrow, hyaline or lightly pigmented hyphae (often difficult to detect) with thin, lightly to intensely pigmented and smooth or rarely roughened walls, to the inside a zone of textura prismatica with the individual cells hyaline to light brown, in the central core the hyphae narrow, parallel to slightly interwoven; hairs absent.

FIG. 4. *Hymenoscyphus fastidiosus*, holotype ex NYS, freehand drawings, x 1,000. A. Median longitudinal section of an apothecium at approximately midpoint between margin and stipe. B. Median longitudinal section of an apothecium through margin. C. An ascus with 8 ascospores. D. A branching paraphysis. E. 7 ascospores drawn after discharge from ascus.


C
D
A
B
E

Habitat: On leaves of *Alnus incana*, *Alnus* sp., and catkins of *Alnus*.

Etymology of the specific epithet: relevance to the fungus uncertain.

Holotype: U.S.A., New York, Forestburgh, on fallen petioles of *Alnus* leaves, Sept., C. H. Peck s.n. (NYS).

Additional specimens examined: U.S.A., New York, Adirondack Mts., on leaves of *Alnus* sp., date not given, C. H. Peck s.n. (NYS); Labrador Lake, near Tully, on old overwintered leaves of *Alnus incana*, 26 Aug 1935, H. H. Whetzel & W. L. White s.n. (CUP 24817 ex FH); Lloyd Preserve, McLean, on *Alnus incana*, leaves on ground, 6 Sept 1935, H. H. Whetzel, W. L. White & Rogers (White 2042 ex FH). Oregon, Tilly Jane Creek, Mt. Hood, on dead alder leaves and petioles, 26 Aug 1933, J. Kienholz K 137 (BPI ex FH). CANADA, Quebec, Duchesnay, County Portneuf, on petioles and lower midribs of *Alnus* leaves, 26 Aug 1938, H. H. Whetzel s.n. (FH); locality as previous collection, 24 Aug 1938, H. H. Whetzel s.n. (FH).

Illustrations: White, Mycologia 34: 158, fig. 2; 166, fig. 9. 1942. White, Farlowia 1: 153, fig. 7. 1943. Arendholz, Morphologisch-taxonomische Untersuchungen an blattbewohenden Ascomyceten aus der Ordnung der Helotiales, pl. 15. fig. 2. 1979.

NOTES. *Helotium fastidiosum* was described by Peck from the U.S.A. as occurring on leaves of *Alnus*. The species does not produce a stroma and is surely referrable to *Hymenoscyphus* as reported recently by Arendholz (1979) who also reported it for the first time from Europe. Structurally the sterile tissue of the apothecium is similar to the common species *Hymenoscyphus caudatus* and *Hymenoscyphus serotinus*, while the ascospore shape is like that of *H. serotinus*. Dumont & Carpenter (1981) pointed out that until recently *H. serotinus* was generally regarded as a species occurring on herbaceous stems. However, they have demonstrated from their studies of neotropical collections that the species is extremely variable, and occurs on leaves as well as on stems. They further reported the ascospores to be (16-)18-23(-30)x3-3.5(-5)µm and indicated that the base of the stipe generally stains light pink in Melzer's Reagent, a reaction also observed in the material studied here. Dennis (1964) reported the ascospore measurements for *H. serotinus* to be 18-28x3-4µm, while Seaver reported them to be 4x22-24µm & Rehm (1893 in 1887-1896) found them to be 30-36x4-6µm. The ascospores studied in the present investigation of *Helotium fastidiosum* were (23-)26-30x2.5-3.5(-4.5)µm and would thus appear to fall within the reported range for *hymenoscyphus serotinus*, and is a probable synonym of *H. serotinus*. I have been unable to find a type of *H. serotinus* and am thus following the generally accepted concept as presented by Dennis (1956, 1964). A final decision on the tentative synonymy can be made only after type material is located or a neotype designated for *H. serotinus*.

8. *Helotium fraternum* Peck, Annual Rep. New York State Mus. 32: 47. 1879.

≡ *Hymenoscyphus fraternus* (Peck) Dennis, Persoonia 3: 76. 1964.

NOTES. *Helotium fraternum* was originally described from New York State as occurring on leaves, and was accepted by

White (1942). Dennis (1964) transferred the species to *Hymenoscyphus*; Arendholz (1979) did not treat the species. Dumont (1981) redescribed and illustrated the species. He found that the species formed a well-defined substratal stroma, produced an ectal excipulum with hyphae embedded in a gelatinous matrix and transferred the species to *Poculum* (Sclerotiniaceae). For a full description, illustrations and discussion, see Dumont (1981).

9. *Helotium immutabile* Fuckel, Jahrb. Nassauischen Vereins Naturk. 25-26: 338. 1871. FIG. 5.

≡ *Hymenoscyphus immutabilis* (Fuckel) Dennis, Persoonia 3: 76. 1964.

Apothecial morphology — Apothecia scattered, arising from leaf blades, short stipitate, ca 1.0-1.5mm in diam, to ca 0.5-0.75mm high, when fresh flat to slightly convex, drying same, rehydrating flat to slightly cupulate. Hymenium when fresh white, drying pale yellow, yellow-brown, or reddish orange, rehydrating slightly lighter and pallid; margin concolorous with hymenium; receptacle when fresh white, drying pale yellow-orange, rehydrating lighter and concolorous in the lower portion with the upper portion of the stipe; stipe in the upper portion similar to receptacle, coloration difficult to observe owing to small size.

Apothecial anatomy — Asci (70-)80-100(-105)x(6-)8-9µm, produced from small croziers, clavate to clavate-cylindric, gradually tapering toward the base and there becoming expanded to form a small foot; wall ca 1µm wide; pore J+. Ascospores (7-)8-10(-12)x2.5-3.5(-4.5)µm, generally biseriate, but occasionally uniseriate, hyaline, smooth, obovoid to trapezoidal, anterior end round or rarely pointed, posterior generally slightly pointed, in outline more or less equilateral, if inequilateral only slightly so and not flattened on one side, walls slightly thickened, eguttulate or less commonly with polar guttulate areas (which are generally obscured and difficult to detect) or in youth biguttulate with guttules disappearing with age. Paraphyses equal to or slightly exceeding the asci, internally hyaline, branching toward the base of the asci, septate, filiform, becoming slightly expanded at the apex and there 2-3µm wide, walls thin, smooth and hyaline. Subhymenium not well differentiated from the medullary excipulum, consisting of parallel, vertically oriented hyphae grading into medullary excipulum. Medullary excipulum well developed, non-refractive, hyaline to pigmented light brown, consisting of septate, branched, parallel or loosely to tightly interwoven hyphae 2-4µm wide, the walls thin, non-refractive, hyaline or rarely pigmented light brown, and smooth. Ectal excipulum: inner ectal excipulum poorly defined and differentiated from medullary excipulum, entire layer non-refractive, hyaline to pigmented light brown, consisting of tightly compact, more or less parallel, hyaline hyphae 2-3µm wide, the walls thin, non-refractive, hyaline and smooth. Outer ectal excipulum non-refractive, entire layer hyaline to subhyaline, variable to ca 35µm broad toward the margin and the same toward the stipe, at the intersection of the stipe and the receptacle to the outside composed of thin-walled, globose cells comprising a well developed textura globulosa, to the inside the hyphae parallel, above the juncture the isodiametric cells giving way to hyphae originating in the stipe and extending almost perpendicularly or at very high angles to the surface, progressing toward the margin the hyphae extending at lower and lower angles to the surface until at the margin the hyphae parallel to the surface of the apothecium, the individual cells with walls thin to slightly thickened, hyaline or rarely pigmented light brown and smooth. Outer covering layer as a distinct layer absent, but with an area to the outside formed of the apical cells of the hyphae extending at low to high angles to the surface and continuing to the surface, and then becoming somewhat expanded and frequently large and clavate, these cells hyaline to slightly yellow-brown with walls thin to slightly thickened and frequently roughened. Margin constructed similarly to the upper portion of the flank, with the individual cells smaller, the apical cells generally unmodified. Hairs absent on the receptacle and margin. Stipe in the upper portion constructed similarly to the lower portion of the receptacle, below to the outside the cells globose with parallel narrow hyphae to the inside; hairs absent.

Habitat: Leaves of *Populus tremula, P. nigra, Quercus pedunculata, Quercus* sp., *Ulmus* sp., *Robinia pseudo-acacia.*

Etymology of the specific epithet: relevance to the fungus uncertain.

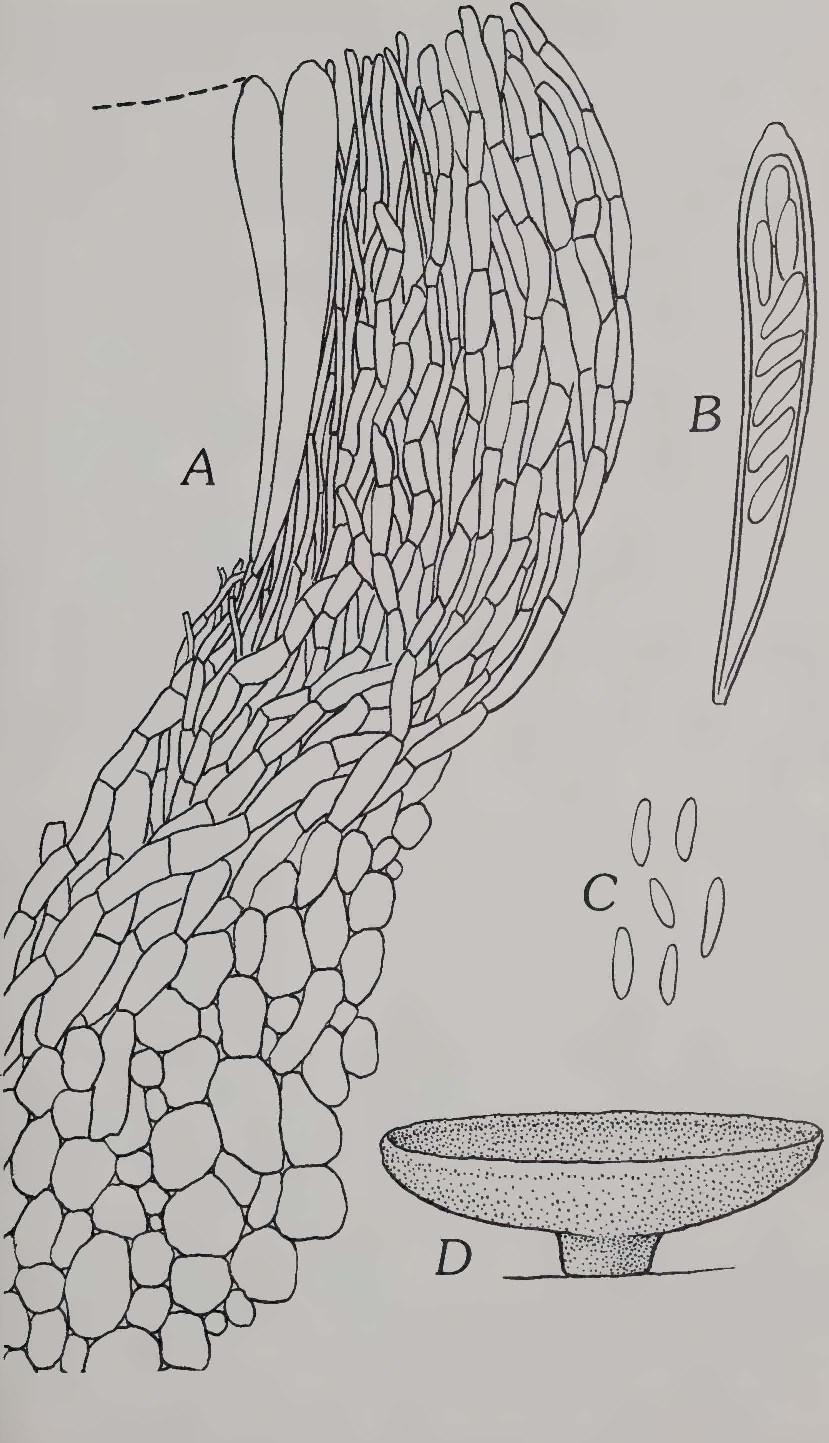
Holotype: Germany, Boss Pr. Ebenbach, ad *Populi tremulae* folia putrida, Fuckel (Fuckel, Fungi rhenani no. 2388, NY probably distributed in Herbier Barbey-Boissier no. 1215.).

Illustrations: Dennis, Mycol. Pap. 62: 93, fig. 85. 1956. White, Farlowia 1: 143, fig. 3. 1943. Arendholz, Morphologisch-taxonomische Untersuchengen an blattbewohenden Ascomyceten aus der Ordnung der Helotiales, pl. 11, figs. 2, 3. 1979.

NOTES. According to White (1943) and Arendholz (1979), *Helotium immutabile* is a widely distributed species in Europe. Dennis (1964) transferred the species to *Hymenoscyphus*, a decision with which I agree, and it appears most closely related to *Helotium epiphyllum*, since both have similar structure of the sterile tissue of the apothecium; the outermost layers of the stipe and base of the receptacle are composed of globose cells, and the receptacle is composed of hyphae originating at the stipe and at the base extending almost perpendicularly to the surface. Further, from the stipe to the margin the hyphae extend at progressively lower angles until toward the margin the hyphae are parallel to the surface.

I have studied few collections of *H. immutabile*; but based on the shape of the ascospores, it appears distinct from *H. epiphyllum*. There is overlap in the measurements, *H. epiphyllum* 12-24x3-5µm (combined measurements according to Dennis, 1956, White, 1943 and Arendholz, 1979) and in *H. immutabile* they are said to be 10-13x4-5µm. It would appear that ascosporen size is of little value in separating these two species. I have attempted to locate the type specimen of *Peziza epiphylla* in the Persoon herbarium at L, but no apothecia remain on the leaf, and all that is present in the type are several apparently unrelated sclerotia, probably non-Sclerotiniaceae. Thus, a final decision on the correct placement of *H.*

FIG. 5. *Hymenoscyphus immutabilis*, Fuckel, Fungi rhenani 2388 ex NY, freehand drawings. A. Median longitudinal section through an apothecium showing lower portion of receptacle and margin, x 1,000. B. An ascus with 8 ascospores. C. 6 ascospores drawn after discharge from ascus, x 1,000. D. Habit sketch of an apothecium on the substrate, x ca 50.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epiphyllum and its relationship with *H. immutabile* can be made only after a neotype specimen is designated for *Peziza epiphylla*, a chore I am not now prepared to do.

10. *Helotium linderi* White, Farlowia 1: 154. 1943.

NOTES. White described *Helotium linderi* from collections from the U.S.A. Dennis (1964) did not treat the species, while Arendholz (1979) placed *H. linderi* into synonymy with *Hymenoscyphus caudatus*, a decision with which I concur.

Holotype: U.S.A., Tenn., Chimney Trail, Great Smokey Mts. Nat. Park, 3200 ft., on fallen leaves, 18 Aug 1939, D. H. Linder (FH).

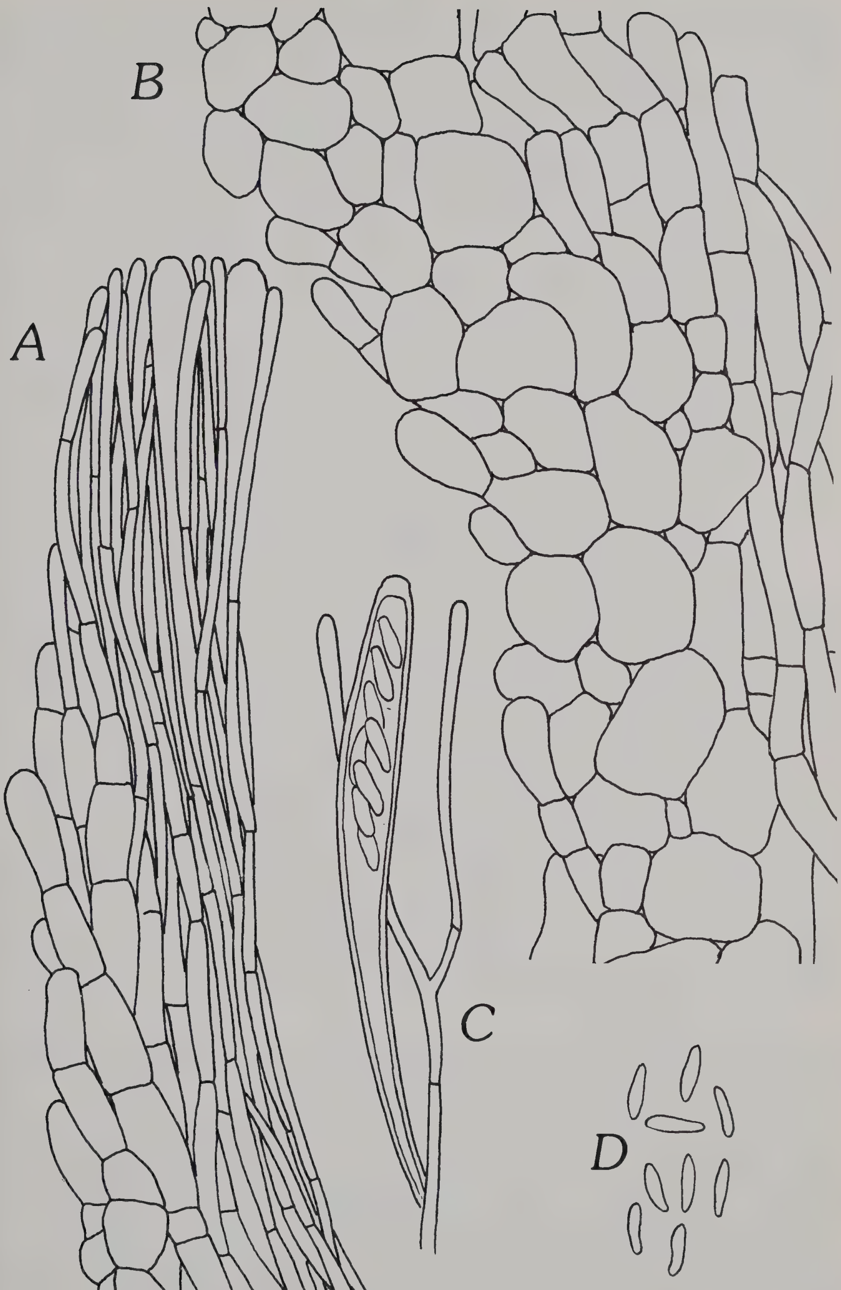
11. *Helotium midlandense* White, Farlowia 1: 605. 1944.
FIG. 6.

Stroma — Substratal, visible on the fruits only as blackened areas of the substrate; in section the blackened areas composed of an irregularly formed rind composed of irregular to epidermoid cells in face view, also visible in cross section of the base of the stipe of the apothecium; not known in culture.

Apothecial morphology — Apothecia solitary, gregarious or occasionally arising in clusters of 3-7, stipitate, unknown in fresh condition, when dry ca 0.5mm in diam and ca 0.5mm high, disc drying flat to slightly cupulate, rehydrating flat and expanded. Hymenium drying shades of yellow to flesh-colored, rehydrating glassy-translucent; margin drying lighter than hymenium, rehydrating concolorous with hymenium; receptacle drying concolorous with the margin, lighter than hymenium, rehydrating glassy-translucent and concolorous with hymenium; stipe concolorous with receptacle in dry and rehydrated conditions, cylindrical, short, generally less than 0.5 mm high and wide, occasionally subpapillate in appearance.

Apothecial anatomy — Asci 8-spored, (40-)52-58(-65)x(5-)6-7μm, produced from small, replicating croziers, cylindric to slightly clavate, gradually tapering toward the base and there becoming slightly expanded to form a small foot, wall to ca 1μm thick, slightly enlarged at the apex and there to ca 2μm thick; pore apparently J- in Melzer's Reagent. Ascospores (5-)6-8(-9)x2-3μm, obliquely uniseriate, irregularly biseriate or biseriate throughout, hyaline, smooth (a few devoid of pigment possibly lightly punctate), aseptate, obovoid to obpyriform, ends rounded or rarely slightly pointed, in outline generally equilateral, anterior end obviously broader than posterior end, occasionally slightly indented below median point of spores; guttules generally absent or rarely with one tiny (ca 1μm or less), transversely positioned at the narrowest portion of the spore and appearing as a septum. Paraphyses equal to or slightly exceeding the asci, internally hyaline, branching toward the base of the asci, septate, cylindrical, generally not becoming expanded at the apex and there 2-3μm wide, walls thin, smooth, and hyaline. Subhymenium well developed, well

FIG. 6. *Helotium midlandense*, Stevens 59 ex NY, freehand drawings, 1,000. A. Median longitudinal section of an apothecium through margin. B. Median longitudinal section of an apothecium through the juncture of receptacle and stipe. C. An ascus with 8 ascospores and a paraphysis. D. 9 ascospores drawn after discharge from ascus.


B
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differentiated from the medullary excipulum below, hyaline, to ca 50µm broad in the center, narrower toward the margin, consisting of parallel to slightly interwoven, vertically interwoven hyphae, the individual hyphae hyaline, 1.5-3µm wide, the walls thin, hyaline and smooth. Medullary excipulum poorly developed, obconical, non-refractive, hyaline, consisting of septate, branched, loosely to tightly interwoven (to parallel in the flank) hyphae 2-3(-4)µm wide, the walls thin, hyaline and smooth. Ectal excipulum: inner ectal excipulum well to poorly defined, well-differentiated from the outer ectal excipulum and grading into the medullary excipulum, entire layer non-refractive, hyaline, 15-20µm broad toward the margin and approximately the same toward the stipe, consisting of parallel to slightly interwoven, hyaline hyphae 2-3µm wide, the walls thin, non-refractive, hyaline and smooth. Outer ectal excipulum non-gelatinized, non-refractive, entire layer hyaline, toward the stipe ca 50µm broad, consisting of large, globose, angular to irregular cells forming a well defined textura globulosa to angularis, the individual cells (5-)8-12(-20)µm wide, the walls thin to slightly thickened, hyaline and smooth. Outer covering layer and hairs absent; progressing towards the margin the outer ectal excipulum becoming narrower, and grading from a textura angularis and globulosa to textura prismatica, the individual cells smaller and forming more and more regular rectangularly shaped cells until at the margin the layer composed of a well defined textura prismatica, lacking an outer covering layer. Margin simple, the brick-shaped cells if continuing into margin only a short distance and the remainder simple and composed of the narrow cells of the inner ectal excipulum and the adjoining paraphyses, hairs also absent in the margin. Stipe constructed similarly to the lower portion of the receptacle, to the outside a zone to ca 70µm broad composed of globose to angular cells and grading into narrow, parallel hyphae in the interior of the stipe; the individual cells with walls thin to slightly thickened, hyaline and smooth or rarely roughened; at the base rind cells visible; hairs absent.

Habitat: Old pods of *Gleditsia triacanthos* L. and reported by White (1944) to occur also on petioles and midveins of *Quercus* sp.

Etymology of the specific epithet: refers to the part of the country where the fungus was originally collected.

Holotype (not examined): Iowa, Homestead, pods of *Gleditsia triacanthos*, 26 Sept 1931, G. W. Martin 5186 (FH).

Illustrations: White, Farlowia 1: 607, figs. 10-13. 1944.

Specimen examined: Kansas, Lawrence, on pods (? of *Gleditsia* sp.), 1890, W. C. Stevens 59 (paratype ex NY).

NOTES. When White (1944) described *Helotium midlandense*, he noted that the stipe to the outside was composed of globose to angular cells, and he illustrated the ectal excipulum as formed of brick-shaped cells in the lower portion approaching the stipe. I have examined a paratype collection and conclude that the majority of the ectal excipulum is composed of a well defined textura globulosa to angularis, but that toward the margin the tissue becomes more organized into a well defined textura prismatica, and not toward the stipe as illustrated by White. Further, I have found a well developed rind on the substrate in association with the apothecia and in section have observed rind cells at the base of the stipe. I have also noted that the spores are relatively small for the Scleotiniaceae and are obovoid to obpyriform. Since the species produces a substratal stroma, it should be referred to the Sclerotiniaceae. Because (i) the ectal excipulum is composed of a textura globulosa, (ii) small pyriform ascospores are present, and (iii) it occurs on fruits, the species is probably best referred to *Ciboria*. At present, I am uncertain of species concepts in *Ciboria* and of the separation between *Ciboria* and *Moellerodiscus*; I will not make a new combination in *Ciboria*, but will defer action until the species are better known.

I have observed in several apothecia a rather high proportion of misshapen and malformed ascospores, some of which produced an apparent septum. I cannot satisfactorily explain the presence of the irregularly formed ascospores, nor the occasional production of a single septum.

My observations are then different from White's, who did not report the presence of a stroma and referred it to the Leotiaceae (*Helotium*). Neither Dennis (1964) nor Arendholz (1979) treat the species.

12. *Helotium phyllogenon* Rehm, Hedwigia 24: 14. 1885.

≡ *Hymenoscyphus phyllogenon* (Rehm) Kuntze, Revis. gen. Pl. 3(3): 485. 1898.

NOTES. *Helotium phyllogenon* was originally described from Hungary on leaves of "poplar." Kuntze (1898) transferred the species to *Hymenoscyphus*, and the placement there was accepted by Dennis (1964) and by Arendholz (1979). I find the type collection to be indistinguishable from *H. caudatus*, following the concept of Dumont & Carpenter (1981). They gave the ascospore measurements of *H. caudatus* to be (14-)16-23(-26)x4-5 (-6)μm, whereas in the original description of *H. phyllogenon* the ascospore measurements were 12-15x3.5μm. White (1943) gave them as 11-14x3.8-5μm, Dennis (1956) 14-16x4-6μm, Arendholz (1979) 11-15x3.5-4.5μm. I find the apothecial structure of the type of *H. phyllogenon* indistinguishable from *H. caudatus*, and conclude that they represent the same species, with the ascospore measurements of the type of *H. phyllogenon* falling at the lower limits of *H. caudatus* and perhaps extending the limits somewhat lower than previously reported by Dumont & Carpenter (1981).

Holotype: Hungary: bei Ungerisch-Altenburg (Ungarn), an faulen Pallel-Blattern, Oct 1883, Linhart (ex FH, Rehm, Ascomyceten 768).

13. *Helotium phyllophilum* (Desmazières) Fries, Summa veg. Scand. p. 356. 1849.

≡ *Peziza phyllophila* Desmazières, Ann., Sci. Nat. Bot., Sér. 2, 17: 98. 1842; *Pl. Crypt (du Nord) France* éd. 1. no. 1159. 1842; éd. 2. Sér. 1. no. 659. 1842.

≡ *Hymenoscyphus phyllophilus* (Desmazières) Kuntze, Revis. gen. Pl. 3(3): 485. 1898.

NOTES. *Peziza phyllophila* was originally described as occurring on leaves of *Acer* and *Fagus* from France and was transferred to *Helotium* by Fries and to *Hymenoscyphus* by Kuntze (1898). Its placement in *Hymenoscyphus* was accepted by both Dennis (1964) and Arendholz (1979). I find the sterile tissue of the apothecium of the lectotype specimen of the species to be indistinguishable from that of *H. caudatus*. The apothecia of *H. phyllophilus* were originally thought to be smaller than those of *H. caudatus*, but as Dumont & Carpenter have pointed out, the apothecia of tropical collections are frequently less than 1mm in diameter and those of the type of *H. phyllophilus* would then fall within the range of *H. caudatus*.

In the original description the measurements of the ascospores were not given, but they were reported to be 1-septate. Dennis (1956) reported the ascospores to be 14-16x3.5-4μm, White (1943) gave them as 11.5-15x3.2-4μm, and Rehm (1893, in 1887-1896) had them 10-15x3-3.5μm. Rehm further placed *Helotium phyllophilum* and *H. phyllogenon* into synonymy. The only difference which I consider noteworthy between *Hymenoscyphus caudatus* and *H. phyllophilus* is that in the latter all of the ascospores in the type collection are 1-septate, whereas, as pointed out by Dumont & Carpenter (1981), in *H. caudatus* they are only rarely 1-septate. However, I have noted in other clearly marked species, such as *H. rufocorneus* (see Dumont, 1981) where for some unexplained reason all of the ascospores in a single collection become 1-septate. I do not consider this then to represent the single criterion upon which to separate two species, *H. caudatus* and *H. phyllophilus*. Rather, I prefer to consider them as probable synonyms.

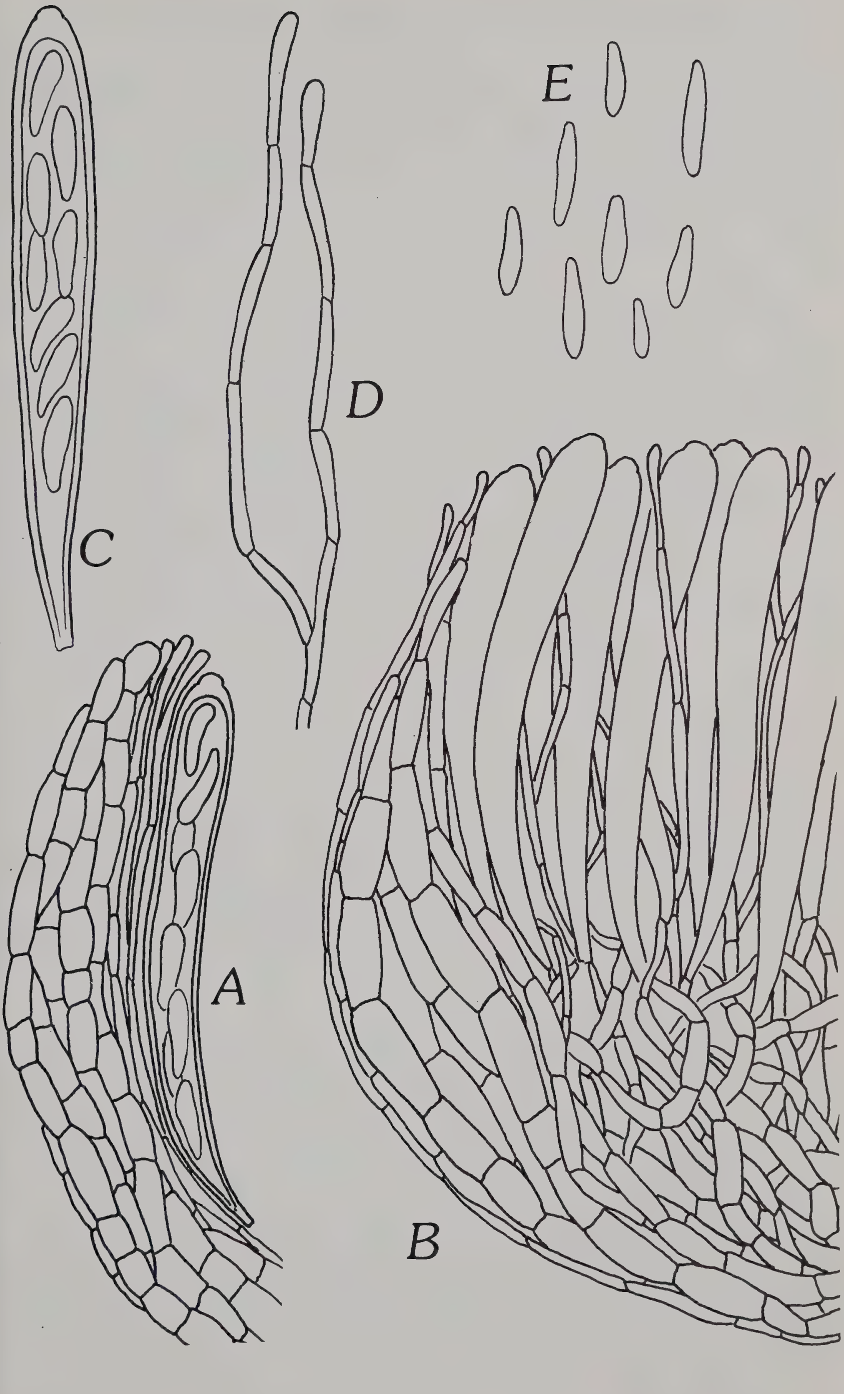
There is some question as to where the name "*Peziza phyllophila*" was actually first published and as to what the type specimen actually is. Desmazières (1842) presented a formal description of the species and a description also appeared on the labels of two specimens cited by Desmazières; "Pl. Crypt. éd. 1, no. 1159; éd. 2, no. 659." As nearly as can be determined (Sayre, 1969), fascicles containing these two specimens were issued simultaneously. I have been unable to determine if the article appeared before the exsiccati specimens.

In this regard, White (1943) selected no. 1159 as the type, but indicated that he examined two specimens, one in the bound set of the exsiccata at FH and the other from the Curtis collections. I select the portion deposited in the bound exsiccata as the lectotype specimen for *Peziza phyllophila*.

Lectotype specimen: Plantes Cryptogames de France, éd. 1, no. 1159 (ex FH, bound set).

14. *Helotium translucens* White, Farlowia 1: 149. 1943.
FIG. 7.

FIG. 7. *Hymenoscyphus translucens*, holotype ex FH, freehand drawings, x 1,000. A. Median longitudinal section of an apothecium through margin. B. Median longitudinal section of an apothecium through margin. C. An ascus with 8 ascospores. D. A branching paraphysis. E. 8 ascospores drawn after discharge from ascus.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≡ *Hymenoscyphus translucens* (White) Arendholz, Morph.-tax. Untersuch. blattbe. Ascomyceten Helotiales p. 78. 1979.

Apothecial morphology — Apothecia tiny, solitary to occasionally gregarious, arising from leaf blades, especially veins of various sizes, with a minute stipe, to ca 0.5mm in diam and to ca 0.4mm high, when fresh disc flat, drying and rehydrating same. Hymenium pallid to hyaline when fresh, drying off-white to pale ochraceous, rehydrating lighter, pale flesh-colored to off-white; margin concolorous with hymenium when fresh, dry and rehydrated; receptacle generally concolorous with the hymenium when fresh, dry and rehydrated; stipe, difficult to observe coloration owing to minute size.

Apothecial anatomy — Asci 8-spored, 80-95x9-11μm, probably produced from tiny croziers, long cylindric-clavate, gradually tapering toward the base and there not expanded to form a small foot, wall ca 1μm wide, slightly enlarged at the rounded to subtruncate apex and there 2(-3)μm thick; pore J+. Ascospores (10-)11-14(-15)x(3-)4(-5)μm, uniseriate to biseriate throughout, hyaline, smooth, aseptate or very rarely 1-septate, trapezoidal, obovoid, ends rounded or less commonly slightly pointed, in outline generally equilateral, if inequilateral only slightly so and then not flattened on one side, anterior end broader than posterior end, frequently appearing eguttulate or with two polar guttulate areas generally obscure but granular and oily in composition, walls slightly thickened and occasionally to ca 1μm wide. Paraphyses equal to or slightly exceeding the asci, internally hyaline, branching at the base of the asci and toward the middle of the asci, filiform, becoming slightly expanded at the apex and there (2-)3-4μm wide, walls thin, smooth and hyaline. Subhymenium not well differentiated from the medullary excipulum, but with a tendency of the hyphae at the base of the asci to be slightly more compact and narrower than the hyphae in the center of the receptacle. Medullary excipulum poorly developed, obconical, non-refractive, hyaline, consisting of septate, branched, more or less parallel to slightly interwoven hyphae 2-4 (-5)μm wide, the walls thin, non-refractive, hyaline and smooth. Ectal excipulum: inner ectal excipulum poorly defined and differentiated from medullary excipulum. Outer ectal excipulum non-refractive, non-gelatinized, entire layer hyaline to subhyaline, ca 15-20μm wide toward the margin and to ca 20-25μm toward the stipe, consisting predominantly of textura prismatica with the individual hyphae extending parallel to or at low to high angles to the surface of the apothecium and without apically free hyphal tips; the individual cells frequently collapsing, becoming disoriented owing to drying process and tissue then appearing to be composed of narrow hyphae; individual cells toward the margin 5-12(-15)x3-5μm and 12-22x3-7μm toward the stipe, the walls thin to slightly thickened and ca 1 μm broad, hyaline to light brown and smooth. Outer covering layer present, but difficult to detect, 1-2 hyphal layers and 1-3μm broad, the individual hyphae extending parallel to the surface of the apothecium, overlapping, terminating before the margin, the individual cells subhyaline, the walls non-refractive, thin, pigmented light brown to intense brown, smooth to frequently slightly roughened. Hairs absent. Margin poorly developed, narrow above, broader below, entire zone hyaline to light brown, constructed similarly to the flank below, the individual cells smaller. Stipe in the upper portion constructed similarly to the lower portion of the flanks, not becoming noticeably interwoven in the center, toward the base the individual hyphae becoming disrupted, and frequently losing hyphal orientation, but generally oriented at a high angle to the surface. Hairs absent.

Habitat: Leaves of *Acer* sp., *Quercus* sp. and *Fagus silvatica* (*fide* Arendholz, 1979).

Etymology of the specific epithet: refers to the color of the apothecium in its fresh condition.

Holotype: U.S.A., Mass., swamp at east side of Great Blue Hill, near Milton, on decaying leaves of *Acer* sp., 11 Nov 1941, D. H. Linder, E. V. Seeler & W. L. White s.n. (FH).

Paratype: U.S.A., Mass., Stony Brook Reservation, West Tuxbury, fallen leaves of *Quercus* sp., 11 Nov 1941, W. L. White s.n. (FH).

Illustrations: White, Farlowia 1: 153, fig. 6. 1943. Arendholz, Morphologisch-taxonomische Untersuchungen an blattbewohenden Ascomyceten aus der Helotiales, pl. 10, figs. 3, 5. 1979.

NOTES. In his description of *Helotium translucens*, White (1943) concluded that this new species was closely related to *Helotium caudatum*, and I am in agreement with this. *Helotium caudatum* is distinguished from *H. translucens* in that the apothecia of *H. translucens* are smaller than those of *H. caudatum* and the ascospores in *H. caudatum* are predominantly inequilateral and frequently hooked apically; in contrast the spores of *H. translucens* are trapezoidal in shape and generally equilateral. The shape of the ascospores in *H. translucens* is suggestive of those of *H. immutabile*. The structure of the apothecia in these two species is fundamentally different. See discussion under *H. immutabile* for a comparison of apothecial structure.

The species was not treated by Dennis (1956, 1964), but I accept the placement of *H. translucens* in *Hymenoscyphus* by Arendholz (1979).

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SUMMARY

Revision of identifications and nomenclature for the first 600 numbers of LICH. EXSICC. COLO is provided, and the following new combinations are proposed: Cladina galapagosensis, C. polia, Heterodermia barbifera, H. circinalis, H. stellata and H. verrucifera. Validation is provided for the publication of three new species distributed in the exsiccati: Lecanora pseudopinguis, L. texana and Psora cerebriformis.

Lichenes Exsiccati, distributed by the University of Colorado Museum (standard abbreviation LICH. EXS. COLO) began in 1961 with the distribution of Fascicle 1 (1-40). The latest fascicle was Fascicle 15 (561-600), distributed in 1979. Some of the early fascicles were distributed in 100 sets, but the current ones are reduced to 60 sets. The exsiccati are offered in exchange to most of the active lichen herbaria of the world. A brief notice was published in Taxon 13:31. 1964, wherein the institutions receiving the complete series were listed. The present paper provides an alphabetical arrangement of the numbers thus far distributed, with updated nomenclature and corrections of identifications up to the present moment. Additional corrections will be welcomed.

In the following list, the first name given is that under which the number was distributed. When that name is enclosed by brackets, this indicates that the name has been changed, and the current name is preceded by an (=) sign. If the identification has been changed, no (=) sign precedes the second name.

TAXON	PROVENANCE	NO.
Acarospora badiofusca (Nyl.) Th. Fr.	Colorado	1
[A. flava (Bell.) Trev.] =A. chlorophana (Wg.) Ach.	Colorado	2
A. nitida H. Magn.	Colorado	522
A. schleicheri (Ach.) Mass.	Arizona	416
[Alectoria chalybeiformis (L.) S. Gray] =Bryoria chalybeiformis (L.) Brodo & Hawksw.	Norway	466
[A. fremontii Tuck.] Bryoria tortuosa (Merr.) Brodo & Hawksw.	California	418
[A. glabra Mot.] Bryoria lanestris (L.) Brodo & Hawksw.	Wyoming	431
A. lata Tayl.	California	417
A. nigricans (Ach.) Nyl.	Tasmania	241
A. ochroleuca (Hoffm.) Mass.	Canada	220
A. poeltii Bystrek	N. Guinea	346
[A. pubescens (L.) R. H. Howe] =Pseudephebe pubescens (L.) Choisy	Canada	219
	Norway	468
A. sarmentosa (Ach.) Ach.	California	132
A. smithii DuRietz	N. Guinea	345
[A. tenuis E. Dahl] Bryoria chalybeiformis (L.) Brodo & Hawksw.	Colorado	125
[Anaptychia barbifera (Nyl.) Trevis.] =Heterodermia barbifera comb. nov.	N. Guinea	379
[A. circinalis (A. Zahlbr.) W. A. Web.] =Heterodermia circinalis comb. nov.	Galapagos	504
[A. diademata (Tayl.) Kurok.] =Heterodermia diademata (Tayl.) Awasthi	Arizona	49
	Mexico	47
A. erinacea (Ach.) Trevis.	Mexico	77
[A. leucomela (L.) Mass. f. verrucifera Kurok.] =Heterodermia verrucifera comb. nov.	Galapagos	509
[A. multiciliata Kurok.] =Heterodermia multiciliata Follm. & Redon	Chile	489
[Anaptychia obscurata (Nyl.) Vain.] =Heterodermia obscurata (Nyl.) Trevis.	Australia	257
[A. stellata (Vain.) Kurok.] =Heterodermia stellata (Vain.) W. A. Web., comb. nov.	Galapagos	508
Anthracothecium ochraceoflavum (Nyl.) Muell.-Arg.	Galapagos	145
Anzia angustata (Pers.) Muell.-Arg.	Australia	281
A. gregoriana Muell.-Arg.	N. Guinea	377
A. hypoleuca Muell.-Arg.	N. Guinea	378
A. wilsonii Raes.	Australia	311
Arthonia glebosa Tuck.	Colorado	53

A. impolita (Ehrh.) Borr. ex Hook. & Sowerby	California	192
	California	477
A. platyspilea Nyl.	Galapagos	122
A. rubella (Fee) Nyl.	Texas	442
Arthopyrenia halodytes (Nyl.) Arn.	Canada	515
[Arthothelium spilomatoides (Nyl.) A. Zahlbr.] A. galapagoense Huneck & Follmann TYPE COLL.	Galapagos	113
Aspicilia alpina (Sommerf.) Arn.	Montana	524
A. desertorum (Kremp.) Mereschk.	Colorado	586
[A. hispida Mereschk.] A. desertorum (Kremp.) Mereschk.	Colorado	144
[A. mutabilis (Ach.) Koerb.] =Pachyospora mutabilis (Ach.) Mass.	N. Mexico	157
A. quartzitica W. A. Web. TYPE COLL.	Colorado	364
A. transbaicalica Oxner	USSR	595
A. sp. indet. (fruticose modification)	California	178
Bacidia albescens (Arn.) Zwackh.	California	182
B. herrei A. Zahlbr.	Oregon	419
B. millegrana (Tayl.) A. Zahlbr.	Galapagos	121
Baeomyces absolutus Hepp in Zollinger	N. Guinea	332
	N. Guinea	334
B. trachypus Nyl.	N. Guinea	335
B. weberi J. W. Thomson TYPE COLL.	N. Guinea	333
Belonia americana Fink ex Hedrick	Texas	355
Bryoria tortuosa (Merr.) Brodo & D. Hawksw.	Canada	579
Buellia curtisii (Tuck.) W. A. Web.	Louisiana	541
B. flavoareolata (Nyl.) Muell.-Arg.	Chile	546
B. galapagona W. A. Web. TYPE COLL.	Galapagos	344
B. glaziouana (Kremp.) Muell.-Arg.	Galapagos	110
B. novomexicana B. de Lesd.	Arizona	408
B. oidalea (Tuck.) Tuck.	California	88
B. punctata (Hoffm.) Mass.	Colorado	208
[B. spuria (Schaer.) Anzi] Incorrect, possibly an undescribed taxon.	Mexico	98
B. cf. taltalensis Dodge	Chile	548
B. triphragmioides Anzi	Colorado	587
B. sp. indet.	Peru	581
B. sp. indet.	Peru	582
B. zahlbruckneri Steiner	Arizona	100
Calicium abietinum Pers.	Idaho	215
[C. hemisphaericum Howard] =C. adequatulum Nyl.	Montana	222
Caloplaca amabilis A. Zahlbr.	Arizona	413
C. aurantiaca (Lightf.) Th. Fr.	Arizona	403
[C. bracteata (Hoffm.) Mass.] Fulgensia desertorum (Tomin) Poelt, cited specimen!	Colorado	134
[C. chrysophthalma Degel.] Determination doubtful.	N. Mexico	161
C. cinnamomea (Th. Fr.) Oliv.	Colorado	197

C. cladodes (Tuck.) A. Zahlbr. in Engler	Colorado	160
C. epithallina Lynge	Colorado	573
C. fernandeziana (A. Zahlbr.) Follm. & Redon	Chile	547
C. lamprocheila (DC.) Flagey	Colorado	64
C. microphyllina (Tuck.) Hasse	Arizona	412
C. modesta (A. Zahlbr.) Fink	Arizona	414
C. pollinii (Mass.) Jatta	Minnesota	535
C. stanfordensis H. Magn.	California	193
C. subnitida (Malme) A. Zahlbr.	Texas	446
C. trachyphylla (Tuck.) A. Zahlbr.	Colorado	282
[Caloplacopsis submexicana (B. de Lesd.) B. de Lesd.] =Candelina submexicana (B. de Lesd.) Poelt	Arizona	405
Candelariella deflexa (Nyl.) A. Zahlbr.	Colorado	398
C. rosulans (Muell.-Arg.) A. Zahlbr.	Colorado	202
	Colorado	283
C. spraguei (Tuck.) A. Zahlbr.	Colorado	3
Catillaria griffithii (Sm.) Malme	California	179
C. sp. indet.	Chile	553
Cavernularia lophyrea (Ach.) Degel.	Canada	517
Cetraria canadensis (Raes.) Raes.	Idaho	223
C. cucullata (Bell.) Ach.	Alaska	42
C. delisei (Bory ex Schaer.) Th. Fr.	Norway	467
C. ericetorum Opiz	Colorado	217
C. fendleri (Nyl.) Tuck.	Arizona	411
[C. fendleri f. coralligera W. A. Web. TYPE COLL.] =C. coralligera (W. A. Web.) Hale	Arizona	99
[C. glauca (L.) Ach.] =Platismatia glauca (L.) W. Culb. & C. Culb.	Colorado	4
C. idahoensis Essl.	Idaho	400
C. islandica (L.) Ach.	Colorado	46
	Australia	274
C. pinastri (Scop.) S. Gray	Colorado	203
[C. richardsonii Hook. in Richards.] =Masonhalea richardsonii (Hook. in Richards.) Kaernefelt	Alaska	54
C. scutata (Wulf.) Poetsch	Tasmania	423
C. tilesii Ach.	Alaska	212
C. sp. indet.	N. Guinea	483
Cetrelia chicitae (W. Culb.) W. Culb. & C. Culb.	N. Guinea	315
Chaenotheca brunneola (Ach.) Muell.-Arg.	Idaho	214
Chiodecton effusum Fee	Galapagos	503
C. farinaceum Fee	Galapagos	498
C. sp. indet.	Chile	551
C. sp. indet.	Chile	557
Chondropsis semiviridis (F. Muell. ex Nyl.) Nyl. ex Cromb.	Australia	225
	Australia	570

Cladia aggregata (Sw.) Nyl.	Nepal	148
	Australia	238
	Galapagos	497
C. ferdinandii (Muell.-Arg.) R. Filson	Australia	571
C. retipora (Labill.) Nyl.	Australia	254
[C. retipora (Labill.) Nyl.] C. corallaizon R. Filson	Australia	237
	Australia	255
C. schizopora (Nyl.) Nyl.	Australia	266
C. sullivanii (Muell.-Arg.) W. Martin	Tasmania	227
[Cladonia alpestris (L.) Rabenh.] =Cladina stellaris (Opiz) Pouzar & Vezda	Alaska	44
[Cladonia cariosa (Ach.) Spreng.] C. robbinsii Evans	Kansas	63
C. ceratophylla (Sw.) Spreng.	Galapagos	502
C. chlorophaea (Flk.) Spreng.	Galapagos	139
C. coccifera (L.) Willd.	N. Guinea	314
C. corymbescens Nyl.	N. Guinea	312
C. ecmocyna Leighton	Colorado	531
C. foliacea (Huds.) Willd.	Denmark	593
[C. galapagosensis Ahti] =Cladina galapagosensis comb. nov.	Galapagos	105
C. leporina Fr.	Alabama	285
C. multiformis Merrill	Colorado	5
	N. Mexico	433
C. pertricosa Kremp.	Australia	267
C. cf. pityrea (Flk.) Fr.	Australia	360
[C. polia R. Sant.] =Cladina polia (R. Sant.) comb. nov.	Galapagos	106
C. scabriuscula (Del. in Duby) Nyl.	Australia	359
	Chile	534
C. solitaria H. Magn.	N. Guinea	342
[C. squamosa (Scop.) Hoffm.] C. dilleniana Flk. fide J. W. Thomson	N. Guinea	313
[C. subtenuis (des Abb.) Evans] =Cladina subtenuis (des Abb.) Hale & W. Culb.	Kansas	52
C. sulphurina (Michx.) Fr.	Montana	527
C. verticillata (Hoffm.) Schaer.	Australia	250
C. vulcanica Zoll. in Hasskarl	N. Guinea	320
[C. xanthoclada Muell.-Arg.] C. capitellata (Tayl.) Bab.	Australia	258
C. zopfii Vain.	Denmark	592
Coelocaulon aculeatum (Schreb.) Gyel.	Colorado	574
	Canada	166
[C. australiense nom. nud.] Cetraria australiense Kaernefelt TYPE COLL.	Australia	454
Coenogonium implexum Nyl.	Tasmania	306
Collema cristatum (L.) G. H. Web. in Wiggers	Colorado	340

C. durietzii Degel.	Australia	438
C. leucocarpum Hook. f. & Tayl.	Australia	253
C. polycarpum Hoffm.	Colorado	392
Conotrema urceolatum (Ach.) Tuck.	W. Virginia	464
[Cora pavonia (Sw.) Fr.] =Dictyonema montanum (Sw.) Marm. ex Follm.	Galapagos	107
[Cornicularia aculeata (Schreb.) Ach.] =Coelocaulon aculeatum (Schreb.) Gyel.	Colorado	6
[C. californica (Tuck.) DuRietz] =Coelocaulon californicum (Tuck.) Howe f.	Oregon	130
C. normoerica (Gunn.) DuRietz	Oregon	128
[Cypheliopsis bolanderi (Tuck.) Vain.] =Thelomma mammosum (Hepp in Hartung) Mass. The collection is mixed, containing also T. santessonii L. Tibell	Mexico	75
Cyphelium inquinans (Sm.) Trev.	Colorado	204
Cystocoleus ebeneus (Dillwyn) Thwaites	Colorado	491
Dactylina madreporiformis (Ach.) Tuck.	Colorado	7
	Colorado	210
Darbishirella gracillima (Kremp.) A. Zahlbr.	Chile	554
Dendrographa leucophaea (Tuck.) Darb.	Mexico	83
	Mexico	493
D. minor Darb.	Calif.	177
Dermatocarpon leptophyllum (Ach.) Vain.	USSR	598
D. miniatum (L.) Mann	Arizona	8
D. plumbeum B. de Lesd.	Colorado	391
D. reticulatum H. Magn.	Oregon	209
D. rivulorum (Arn.) Dalla Torre & Sarnth.	Colorado	394
D. tuckermanii (Rav. ex Mont.) A. Zahlbr.	Arizona	95
D. vellereum Zschacke	USSR	596
Dictyonema irpicinum Mont.	N. Guinea	361
D. sericeum (Sw.) Berk.	N. Guinea	362
Diploicea canescens (Dicks.) Mass.	California	184
Diploschistes ocellatus (Vill.) Norm.	Mexico	578
[D. scruposus (Schreb.) Norm.] D. cf. canadensis Raes.	Colorado	9
Dirina catalinariae Hasse	Mexico	76
D. herrei A. Zahlbr.	Galapagos	367
D. limitata Nyl.	Chile	549
Dolichocarpus chilensis R. Sant.	Chile	560
Endocarpon pulvinatum Th. Fr.	Colorado	291
E. pusillum Hedw.	Colorado	10
	Colorado	429
Enterographa atacamensis Dodge	Peru	583
[Enterographa atacamensis Dodge] Roccellina olivacea Follm.	Chile	555
Ephebe lanata (L.) Vain.	Colorado	59
Evernia prunastri (L.) Ach.	California	187

Everniastrum neocirrhatum (Hale & V. Wirth) Hale	Mexico	487
E. vexans Hale	Galapagos	499
Glypholecia scabra (Pers.) Muell.-Arg.	USSR	600
Graphis caesiella Vain.	Galapagos	480
G. striatula (Ach.) Spreng.	Galapagos	142
Gyrostomum scyphuliferum (Ach.) Nyl.	Louisiana	542
Haematomma babingtonii Mass.	New Zealand	296
H. subpuniceum (Muell.-Arg.) B. de Lesd.	Texas	11
Heppia lutosa (Ach.) Nyl.	Iowa	297
Heterodea muelleri (Hampe) Nyl.	Australia	172
Heterodermia leucomelos (L.) Poelt	Mexico	577
[Hubbsia lumbricoides W. A. Web. TYPE COLL.] =Reinkella californica Raes.	Mexico	85
Hydrothyria venosa Russell	California	293
Hypogymnia billardieri (Mont.) R. Filson	Australia	382
H. krogii Ohlsson	N. Carolina	529
H. lugubris (Pers.) Krog	Australia	351
H. mundata (Nyl.) Rassadina	Australia	385
H. oroarctica Krog	Colorado	572
H. physodes (L.) Nyl.	Colorado	133
Icmadophila ericetorum (L.) A. Zahlbr.	Colorado	164
Ingaderia pulcherrima Darb.	Chile	558
Koerberia biformis Mass.	Arizona	12
Lasallia pensylvanica (Hoffm.) Llano	Colorado	13
L. pustulata (L.) Mereschk. ssp. papulosa (Ach.) W. A. Web.	Texas	14
	Colorado	15
Lecanactis californica Tuck.	California	194
L. cf. myriadea (Fee) A. Zahlbr.	Chile	550
L. (subg. Bactrospora) sp. indet.	California	456
[Lecanora arizonica (Tuck.) W. A. Web.] =Omphalodium arizonicum (Tuck.) Tuck.	N. Mexico	16
L. badia (Hoffm.) Ach.	Montana	523
[L. bolanderi Tuck.] L. phryganitis Tuck.	California	165
[L. cancriformis (Hoffm.) Vain.] L. caesiorubella Ach. ssp. merrillii Imsh. & Brodo	California	181
L. carpinea (L.) Vain.	California	183
L. chlarotera Nyl.	Colorado	200
L. christoi W. A. Web. TYPE COLL.	Colorado	458
L. confusa Almborn	Oregon	420
[L. conizaea (Ach.) Nyl.] Incorrect, but no alternative identification available.	Galapagos	138
[L. conizaeoides Nyl. ex Cromb.] L. confusa Almb.	California	180
L. coquimbensis A. Zahlbr.	Chile	552
L. frustulosa (Dicks.) Ach.	Colorado	17
L. garovaglii (Koerb.) A. Zahlbr. (Disregard comments)	Colorado	118

[L. cf. glabrata (Ach.) Malme] Probably incorrect but no alternative name available.	Texas	436
[L. lentigera (G. Web.) Ach.] =Squamarina lentigera (G. Web.) Poelt	Colorado	18
[L. marginalis Hasse] =Rhizoplaca marginalis (Hasse) W. A. Web.	California	126
[L. melanophthalma Ram.] =Rhizoplaca melanophthalma (Ram.) Leuckert & Poelt	Colorado	368
	Wyoming	430
L. mellea W. A. Web. TYPE COLL.	California	462
[L. peltata (Ram.) Steud.] =Rhizoplaca peltata (Ram.) Leuckert & Poelt	Colorado	119
	Colorado	460
L. phryganitis Tuck.	California	475
L. pinguis Tuck.	Mexico	87
L. polytropa (Ehrh.) Rabenh.	Colorado	521
L. pringlei M. Lamb	Colorado	135
L. pseudopinguis W. A. Web. sp. nov. TYPE COLL.	Galapagos	500
[L. rubina (Vill.) Ach.] =Rhizoplaca chrysoleuca (Sm.) Choisy	Colorado	19
L. saligna (Schrad.) A. Zahlbr.	Colorado	395
L. texana W. A. Web., sp. nov. TYPE COLL.	Texas	451
[L. thomsonii H. Magn.] =L. novomexicana B. de Lesd. ex H. Magn.	Colorado	20
L., stirps varia (Ehrh.) Ach.	Colorado	563
Lecidea aspidula Kremp.	Australia	273
[L. atrobrunnea (Ram.) Schaer.] L. leucothallina Arn.	Colorado	155
L. berengeriana (Mass.) Th. Fr.	Colorado	21
	Oregon	428
[L. cinnabarina Sommerf.] Protoblastenia russula (Ach.) Raes.	Australia	259
[Lecidea decipiens Ach.] =Psora decipiens Hoffm. (Ignore the incorrect synonymy on the label)	Colorado	22
L. dolodes Nyl. ex Hasse	California	478
L. elabens Fr.	Australia	277
L. elata Schaer.	Colorado	481
[L. friesii Ach. in Liljebl.] =Hypocenomyce friesii (Ach. in Liljebl.) G. Schneider	Australia	272
[L. icterica (Mont.) Tayl.] =Psora icterica (Mont.) Muell.-Arg.	N. Mexico	435
L. insularis Nyl.	Montana	141
L. leucothallina Arn.	Montana	525
L. limosa Ach.	N. Guinea	567
[L. luridella Tuck.] =Psora luridella (Tuck.) Fink	Colorado	482
L. lyngei Degel.	Colorado	424

[L. novomexicana (B. de Lesd.) W. A. Web. ex R. Anderson] =Psora nipponica (A. Zahlbr.) G. Schneider	Idaho	224
L. nylanderi (Anzi) Th. Fr.	Minnesota	536
[L. quadricolor (Dicks.) Borr.] =L. granulosa (Hoffm.) Ach.	Arizona	103
[L. rubiformis (Wahlenb. ex Ach.) Ach.] Psora tuckermanii R. Anderson ex G. Schneider, invalid. no Latin description.	Colorado	23
[L. rubiformis (Wahlenb. ex Ach.) Ach.] Psora cerebriformis W. A. Web., sp. nov.	Colorado	24
[L. rufonigra (Tuck.) Nyl.] =Psorula rufonigra (Tuck.) G. Schneider	Colorado	124
	Texas	450
[L. symmicta (Ach.) Ach.] Lecanora cadubriae (Mass.) Hedlund	Colorado	81
[L. texana W. A. Web.] =Xanthopsora texana (W. A. Web.) G. Schneider & W. A. Web. TYPE COLL.	Texas	448
[L. wallrothii Flk. ex Spreng.] =Trapeliopsis wallrothii (Flk. ex Spreng.) H. Hertel & G. Schneider	California	127
Lecidella elaeochroma (Ach.) Haszl.	Colorado	520
[Leprocaulon albicans (Th. Fr.) Nyl. ex Hue] =Leprocaulon gracilescens M. Lamb & Ward	Arizona	25
	Colorado	26
L. arbuscula (Nyl.) Nyl. ex Hue	N. Guinea	290
[L. microscopicum (Vill.) Gams ex D. Hawksw.] L. tenellum (Tuck.) Nyl.	Galapagos	496
Leprocaulon tenellum (Tuck.) Nyl.	Peru	584
Leptogium brebissonii Mont. in Webb	Australia	317
L. burnetiae Dodge var. hirsutum (Sierk) P. M. Joerg.	Colorado	486
L. cyanescens (Ach.) Koerb.	Galapagos	506
L. denticulatum Nyl.	Colorado	78
[L. foveolatum Nyl.] L. punctulatum Nyl.	Mexico	56
	Galapagos	505
[L. furfuraceum (Harm.) Sierk] L. papillosum (B. de Lesd.) Dodge	Arizona	96
L. hypotrachynum Muell-Arg.	Australia	388
L. javanicum (Mont. & v. d. Bosch) Mont.	N. Guinea	295
L. lichenoides (L.) A. Zahlbr.	Colorado	50
	Oregon	421
L. millegranum Sierk	Arizona	97
	Arizona	159
L. moluccanum (Pers. in Gaud.) Vain.	N. Guinea	381
L. phyllocarpum (Pers.) Mont.	Mexico	55
L. rugosum Sierk	Arizona	102
Letharia vulpina (L.) Hue	California	512
L. vulpina (L.) Hue f. californica (Lev.) W. A. Web.	Nevada	120
Lichina confinis (O. F. Muell.) C. A. Agardh	Tasmania	234

L. tasmanica Henssen	Tasmania	393
Lobaria hallii Tuck.	Oregon	401
L. retigera (Bory) Trevis.	India	149
[L. stictaeformis (Schaer.) Trevis.] L. discolor (Bory in Del.) Hue	N. Guinea	347
Lopadium pezizoideum (Ach.) Koerb.	Idaho	221
Maronella laricina Steiner ISOTYPES	Austria	588
Mastodia tessellata auct. (See Brodo, The Bryologist 79:396-398. 1977, for nomenclatural discussion)	Alaska	27
Melanaria melanospora (Nyl.) Erichsen	Chile	545
[Menegazzia aeneofusca (Muell.-Arg.) R. Sant.] M. nothofagi P. James ined.	Australia	232
M. pertusa (Schrank) Stein	N. Guinea	384
Micarea denigrata Fr.) Hedlund	Colorado	73
Microthelia micula Koerb.	Arizona	67
Mycoglaena myricae (Nyl.) R. C. Harris	Colorado	519
Neophyllis melacarpa (F. Wils.) F. Wils. G. Schneider maintains this over Yoshimura's placement in Gymnoderma	Australia	246
Nephroma arcticum (L.) Torss.	Alaska	43
N. australe A. Richard	Tasmania	569
N. cellulosum (Sm. ex Ach.) Ach.	Australia	239
N. helveticum Ach.	Colorado	28
N. resupinatum (L.) Ach.	Alaska	170
[Nephromopsis californica Gyel.] =Cetraria orbata (Nyl.) Fink	California	129
Neuropogon acromelanus (Stirt.) M. Lamb	Tasmania	247
N. sulphureus (Koenig) Hellb.	Spitzbergen	591
Normandina pulchella (Borr.) Nyl.	Australia	276
Ocellularia alba (Fee) Muell.-Arg.	Australia	352
Ochrolechia grimmiae Lynge	Spitzbergen	590
O.upsaliensis (L.) Mass.	Colorado	57
Omphalaria kansana Tuck. Determination doubtful.	Colorado	173
Opegrapha saxicola Ach.	California	198
Pannaria leucophaea (Vahl) P. M. Joerg.	USSR	599
[P. nigrata Muell.-Arg.] Possibly P. tavaresii P. M. Joerg., cf. Opera Bot. 45:70. 1978.	Australia	386
P. pezizoides (G. Web.) Trevis.	Colorado	396
Parathelium sp. indet.	Chile	556
[Parmelia bostrychodes A. Zahlbr.] =Hypotrachyna bostrychodes (A. Zahlbr.) Hale	N. Guinea	376
[P. caperata (L.) Ach.] =Pseudoparmelia caperata (L.) Hale	Australia	270
[P. chiricahuensis R. Anderson & W. A. Web.] =Neofuscelia chiricahuensis (R. Anderson & W. A. Web.) Essl.	Arizona Texas	91 444

[P. conspersa (Ach.) Ach.] Xanthoparmelia chlorochroa (Tuck.) Hale	Wyoming	29
[P. dichotoma Muell.-Arg.] =Xanthoparmelia dichotoma (Muell.-Arg.) Hale	Australia	322
[P. dominicana Vain.] =Parmotrema dominicana (Vain.) Hale	Galapagos	136
[P. elegantula (A. Zahlbr.) Szatala] =Melanelia elegantula (A. Zahlbr.) Essl.	Colorado	207
[P. endosulphurea (Hillm.) Hale] =Parmotrema endosulphureum (Hillm.) Hale	Dominica	336
[P. exasperatula Nyl.] =Melanelia exasperatula (Nyl.) Essl.	Colorado	154
[P. furfuracea (L.) Ach.] Pseudevernia intensa (Nyl.) Hale & W. Culb.	Texas	30
[P. galbina Ach.] =Parmelina galbina (Ach.) Hale	Australia	244
[P. isidiotyla Nyl.] Neofuscelia loxodes (Nyl.) Essl.	Colorado	153
[P. novomexicana Gyel.] =Xanthoparmelia novomexicana (Gyel.) Hale	Arizona	404
[P. perlata (Huds.) Ach.] =Parmotrema perlatum (Huds.) Hale	Australia	279
[P. physodes (L.) Ach.] =Hypogymnia physodes (L.) Nyl.	Colorado	68
P. praesignis Nyl.	N. Mexico	156
P. pseudotenuirima Gyel.	Australia	365
[P. pulla (Schreb.) Ach.] =Neofuscelia pulla (Ach.) Essl.	Australia	271
[P. pulvinata Fee] =Hypotrachyna pulvinata (Fee) Hale	Arizona	101
[P. revoluta Flk.] =Hypotrachyna revoluta (Flk.) Hale	Colorado	463
[P. rutidota Hook. f. & Tayl.] =Pseudoparmelia rutidota (Hook. f. & Tayl.) Hale	Australia	268
P. saxatilis (L.) Ach.	Colorado	538
[P. saximontana R. Anderson & W. A. Web.] TYPE COLL. =Melanelia substygia (R. Anderson & W. A. Web.) Essl.	Colorado	41
P. signifera Nyl.	Australia	251
P. subalbicans Stirt.	Australia	280
[P. subcrinita Nyl.] =Parmotrema subtinctorium (Nyl.) Hale	Dominica	339
P. subrudecta Nyl.	Australia	349
[P. substrigosa Hale in W. A. Web.] =Xanthoparmelia substrigosa (Hale in W. A. Web.) Hale	Australia	338
[P. subtinctoria A. Zahlbr.] =Parmotrema subtinctorium (A. Zahlbr.) Hale	Australia	278
	Arizona	410

[P. taractica Kremp.] =Xanthoparmelia taractica (Kremp.) Hale	Arizona	409
[P. tinctorum Nyl.] =Parmotrema tinctorum (Nyl.) Hale	Galapagos	114
[P. ulcerosa A. Zahlbr.] =Xanthoparmelia ulcerosa (A. Zahlbr.) Hale	Venezuela	469
[P. ulophyllodes (Vain.) Sav.] =P. soredica Nyl.	Colorado	213
[P. weberi Hale] =Xanthoparmelia weberi (Hale) Hale	Arizona	415
[P. wyomingica (Gyel.) Hale] =Xanthoparmelia wyomingica (Gyel.) Hale	Wyoming	465
Parmeliopsis aleurites (Ach.) Nyl.	Arizona	406
P. placorodia (Ach.) Nyl.	Colorado	31
	Arizona	65
Peccania sp. indet.	Mexico	576
Peltigera aphthosa (L.) Willd.	Colorado	32
Peltigera dolichorhiza (Nyl.) Nyl.	Australia	245
	N. Guinea	321
P. horizontalis (Huds.) Baumg.	Colorado	71
	N. Guinea	319
P. horizontalis (Huds.) Baumg. f. zopfii (Gyel.) J. W. Thomson	Colorado	485
P. polydactyla (Neck.) Hoffm.	Alaska	171
	Oregon	422
[P. scabrosa Th. Fr.] P. sp. nov. Vitikainen ined.	Colorado	484
P. venosa (L.) Willd.	Colorado	33
Peltula cylindrica Wetmore	Georgia	402
P. obscurans (Nyl.) Gyel. var. deserticola (A. Zahlbr.) Wetmore	Arizona	397
Pertusaria californica Dibben	California	473
P. saximontana Wetmore	Colorado	459
P. xanthodes Muell.-Arg.	Louisiana	539
Pertusaria (Subg. Lecanorastrum) sp. indet.	Tasmania	479
[Phaeographina tridacna W. A. Web. sp. nov. ined.] P. isidiosa (Vain.) A. Zahlbr., det. Nakanishi.	N. Guinea	390
Phaeographis exaltata (Mont. & v. d. Bosch) Muell.-Arg.	Mexico	74
P. sp. indet.	Galapagos	514
Phylliscum demangeonii (Moug.) Nyl.	Colorado	45
Physcia adscendens (Th. Fr.) Oliv. em. Bitt.	Colorado	152
[P. aegialita (Ach.) Nyl.] Dirinaria subconfluens Awasthi, cited specimen.	Australia	242
P. caesia (Hoffm.) Hampe Identification incorrect, but no alternative available.	Australia	269
P. callosa Nyl.	Colorado	60
P. duplicorticata W. A. Web. & J. W. Thomson TYPE COLL.	Calif.	476

[P. pulverulenta (Schreb.) Hampe f. coralloidea Suza in Nadv.] Physconia sp. indet.	N. Mexico	158
[P. setosa (Ach.) Nyl.] P. hispidula (Ach.) Frey	Arizona	93
[P. setosa (Ach.) Nyl.] Identification incorrect.	Australia	252
P. stellaris (L.) Nyl.	Colorado	201
P. tribacoides Nyl.	Louisiana	437
P. vitii Nadv.	Germany	589
Physconia detersa (Nyl.) Poelt	Colorado	399
P. muscigena (Ach.) Poelt	Colorado	341
Physma byrsinum (Ach.) Muell.-Arg.	N. Guinea	363
Pilophoron robustum Th. Fr.	Alaska	34
Placynthium nigrum (Huds.) S. Gray	Ohio	457
Platismatia stenophylla (Tuck.) W. Culb. & C. Culb.	Canada	516
Polychidium muscicola (Sw.) S. Gray	Colorado	58
	Colorado	490
Porina epiphylla Fee	Cocos I.	143
	Australia	370
P. rubentior (Stirt.) Muell.-Arg.	Cocoa I.	143
P. sp. indet.	Chile	561
Pseudocyphellaria argyracea (Del.) Vain.	Australia	307
P. australiensis H. Magn.	Australia	318
[P. durvillei (Del.) Vain.] P. hirta (G. Forst.) D. Gall. & P. James	Tasmania	383
[P. freycinetii (Del.) Malme] Identification dubious.	Australia	389
	Tasmania	387
P. gilva (Ach.) Malme	N. Guinea	373
P. glabra (Hook. f. & Tayl.) Dodge	Tasmania	310
P. impressa (Hook. f. & Tayl.) Vain.	Tasmania	308
P. neglecta (Muell.-Arg.) H. Magn.	Australia	372
[P. orygmaea (Ach.) Malme] P. hirta (G. Forst.) D. Gall. & P. James	Tasmania	264
P. sp. indet.	Australia	565
P. rainierensis Imshaug	Washington	123
Psoroma soccatum R. Br. in Cromb.	Australia	461
P. sphinctrinum (Mont.) Nyl.	Tasmania	256
Psorotichia minuta H. Magn.	Colorado	196
P. sp. indet.	Texas	449
Pyrenotrichum splitgerberi Mont.	Louisiana	286
Pyrenula cerina Eschw.	Galapagos	146
P. nitidella (Flk. ex Schaer.) Muell.-Arg. var. maculata R. C. Harris TYPE COLL.	Texas	443
Pyxine pringlei Imshaug	Galapagos	111
[Ramalina ceruchis (Ach.) DeNot.] =Desmazieria ceruchis (Ach.) Trevis.	Mexico	79
[R. combeoides Nyl.] =Desmazieria combeoides (Nyl.) Follm. & Huneck	Mexico	89
R. complanata (Sw. ex Ach.) Ach.	Galapagos	147

R. farinacea (L.) Ach.	Galapagos	168
	California	186
R. fraxinea (L.) Ach. Identification doubtful.	Australia	348
R. geniculata Hook. *f.* & Tayl. *var. compacta* Muell.-Arg.	Tasmania	350
[*R. homalea* Ach.] =*Desmazieria homalea* (Ach.) Mont.	Mexico	82
	California	185
R. javanica Nyl.	N. Guinea	343
R. linearis (Sw.) Ach.	Galapagos	167
R. menziesii Tayl., *non* Tuck.	Mexico	511
R. pacifica Asahina	Philippines	533
R. peruviana Ach.	Galapagos	510
R. sinensis Jatta	N. Mexico	434
R. sorediantha Nyl.	Galapagos	137
	Galapagos	169
R. subleptocarpha Rundel & Bowler	Mexico	564
R. usnea (L.) Howe *f.*	Panama	90
	Galapagos	115
[*Ramalodium succulentum* (R. Br.) Nyl.] *Arctomia fruticosa* Henssen & Weber. *sp. nov. ined.*	Tasmania	452
Reinkella lirellina Darb.	Peru	580
R. parishii Hasse	California	176
Rhizocarpon macrosporum Raes.	Colorado	518
Rinodina applanata H. Magn.	Louisiana	540
[*R. archaea* (Ach.) Vain. *em.* Malme] Sheard questions the identification.	California	199
	California	206
R. calculiformis W. A. Web. TYPE COLL.	Mexico	94
R. coloradiana H. Magn.	Colorado	537
R. marysvillensis H. Magn.	California	474
[*R. oreina* (Ach.) Mass.] =*Dimelaena oreina* (Ach.) Norm.	Colorado	35
[*R. radiata* (Tuck.) Tuck.] =*Dimelaena radiata* (Tuck.) Hale & W. Culb.	California	189
R. turfacea (Wahlenb.) Koerb.	Colorado	292
Roccella babingtonii Mont.	Mexico	80
	Galapagos	109
R. fimbriata Darb.	Mexico	84
	Mexico	86
R. fucoides (Dicks.) Vain.	Italy	594
R. portentosa Darb.	Chile	492
[*R. portentosa* Darb.] *R. galapagoensis* Follm. TYPE COLL.	Galapagos	112
	Galapagos	117
Roccellaria mollis (Hampe) A. Zahlbr.	Chile	559
	Peru	585
Roccellina condensata Darb.	Chile	544

[R. lutosa Follm.] Roccellina luteola Follm.	Chile	543
Sarcogyne clavus (Ram.) Kremp.	Texas	445
S. regularis Koerb.	Texas	441
Schismatomma cupressum Herre	California	195
Schistophoron tenue Stirt.	Galapagos	495
Schizopelte californica Th. Fr.	California	175
Siphula coriacea Tayl. ex Nyl.	Australia	243
	Australia	275
Siphula fragilis (Hook. f. & Tayl.) J. Murray, nom. nud.	Tasmania	265
S. sp. indet.?	California	455
Speerschneidera euploca (Tuck.) Trevis.	Texas	447
Sphaerophorus melanocarpus (Sw.) DC.	Tasmania	289
S. tener Laur.	Tasmania	294
Sporastatia testudinea (Ach.) Mass.	Colorado	36
Staurothele clopima (Wahlenb. ex Ach.) Th. Fr.	California	427
Stereocaulon glareosum (Sav.) H. Magn.	Colorado	66
	Montana	528
S. leprocauloides M. Lamb TYPE COLL.	N. Guinea	299
S. massartianum Hue	N. Guinea	302
	Philippines	532
[S. microcarpum Muell.-Arg.] S. weberi M. Lamb, TYPE COLL.	Galapagos	494
S. myriocarpum Th. Fr.	N. Guinea	304
[Stereocaulon piliferum Th. Fr.] misspelling for S. piluliferum Th. Fr.	India	150
S. pseudomassartianum M. Lamb ex Frey	N. Guinea	300
	N. Guinea	301
	N. Guinea	303
S. ramulosum (Sw.) Raeusch var. nudatum (Muell.-Arg.) Muell.-Arg.	Australia	249
S. rivulorum H. Magn.	Colorado	530
S. staufferi M. Lamb ex Frey	N. Guinea	305
S. virgatum Ach. ex Spreng.	Dominica	337
Sticta boschiana Mont. & v. d. Bosch ex Jungh.	N. Guinea	374
S. filix (Sw.) Nyl.	Australia	248
S. [Pseudocyphellaria] cf. fragillima Bab. ex Hook., sensu A. Zahlbr.	N. Guinea	375
S. fuliginosa (Dicks.) Ach.	Australia	240
S. rubella Hook. f. & Tayl.	Tasmania	309
S. weigelii Isert ex Ach.	Arizona	92
Strigula elegans (Fee) Muell.-Arg.	Louisiana	284
	Australia	371
Teloschistes exilis (Michx.) Vain.	Texas	356
T. fasciculatus Hillm.	Australia	286
T. flavicans (Sw.) Norm.	Galapagos	108
T. velifer F. Wils.	Australia	235

T. villosus (Ach.) Norm.	Mexico	191
Thamnolia vermicularis (Sw.) Schaer.	Colorado	37
	Alaska	211
	Australia	226
T. vermicularis (Sw.) Ach. *ssp. solida* (Sato) W. A. Web.	N. Guinea	380
[*Thelidea corrugata* Hue] =*Knightiella splachnirima* (Hook. f. & Tayl.) Gyel.	Tasmania	353
Thelotrema diminitum Hale, Cited specimen.	Australia	453
Thrombium epigaeum (Pers.) Wallr.	Colorado	426
Thysanothecium hookeri Berk. & Mont.	Australia	369
T. hyalinum (Tayl.) Nyl.	Australia	218
Toninia bullata (Mey. & Flot.) A. Zahlbr.	Australia	233
[*T. ruginosa* (Tuck.) Herre] *T. sp. nov. ined.*	Colorado	140
T. tristis Th. Fr.	Colorado	174
Trypethelium grossum Muell.-Arg.	N. Guinea	358
T. mastoideum (Ach.) Ach.	Louisiana	287
T. tropicum (Ach.) Muell.-Arg.	Louisiana	288
Umbilicaria arctica (Ach.) Nyl.	Norway	470
U. coriacea Imshaug	Norway	471
U. cylindrica (L.) Del. *ex* Duby	Australia	228
U. decussata (Vill.) A. Zahlbr.	Australia	230
U. deusta (Huds.) Baumg.	Colorado	425
U. havaasii Llano	Norway	472
U. hirsuta (Sw.) Ach.	Colorado	69
U. hyperborea (Ach.) Hoffm.	Colorado	162
U. kraschenimnikovii (Sav.) A. Zahlbr.	Colorado	216
U. phaea Tuck.	California	131
U. proboscidea (L.) Schrad.	Australia	229
U. subglabra (Nyl.) Harm.	Australia	231
U. vellea (L.) Ach.	Colorado	38
[*U. vellea* (L.) Ach.] *U. cinereorufescens* (Schaer.) Frey *sensu* Llano	Colorado	39
Usnea angulata Ach.	Mexico	51
U. angulosa (Muell.-Arg.) Mot.	Australia	331
U. arbusculiformis Mot.	Mexico	70
U. capillacea Mot.	Tasmania	261
	Tasmania	440
U. cavernosa Tuck. *in* Agassiz	Arizona	48
	Mexico	298
U. cf. cladocarpa Fee	Galapagos	507
U. comosa (Ach.) Roehl.	Arizona	104
[*U. diplotypus* Vain.] *U. herrei* Hale. *nom. nud.*	Kansas	61
	Texas	62
U. aff. elongata Mot.	Galapagos	501
U. flexilis Stirt.	Tasmania	263
	N. Guinea	568

U. herrei Hale, nom. nud.	Arizona	407
U. igniaria Mot.	Chile	562
U. inermis Mot.	Tasmania	262
U. cf. merrillii Mot.	Mexico	488
U. microcarpoides (Muell.-Arg.) Mot.	Australia	329
U. mutabilis Stirt.	Texas	357
U. paradoxa (A. Zahlbr.) Mot.	Galapagos	366
U. poliotrix Kremp.	Australia	326
	Australia	327
	Australia	328
[U. rubiginea (Michx.) Mass.] U. rubicunda Stirt.	Australia	260
U. scabrata Nyl. ssp. nylanderiana Mot.	USSR	597
U. scabrida Tayl.	Tasmania	323
	Tasmania	324
[U. sorediifera auctt.] =U. fulvoreagens (Raes.) Raes. cf. Brodo in The Bryologist 79:406. 1976 [1977].	Colorado	72
	Colorado	205
	Wyoming	432
U. spilota Stirt.	Australia	566
U. cf. strigosa (Ach.) Eaton	Mexico	575
U. torquescens Stirt.	Australia	316
U. torulosa (Muell.-Arg.) A. Zahlbr.	Australia	325
	Tasmania	330
[U. tristis Mot.] U. florida (L.) Wigg., fide Asahina, J. Jap. Bot. 43:65. 1968.	N. Mexico	116
U. xanthopoga Nyl.	Tasmania	439
Verrucaria laevata Ach.	S. Dakota	40
Xanthoparmelia wyomingica (Gyel.) Hale	Colorado	513
Xanthoria candelaria (L.) Th. Fr.	Mexico	190
X. fallax (Hepp ex Arn.) Arn. sens. latiss.	Texas	354
X. polycarpa (Ehrh.) Rieb.	Colorado	151
X. polycarpa (Ehrh.) Rieb. Identification doubtful.	California	188
[Xylographa spilomatica (Anzi) Th. Fr.] =X. vitiligo (Ach.) Laundon	Colorado	163
X. vitiligo (Ach.) Laundon	Montana	526

NEW COMBINATIONS

Cladina galapagosensis (Ahti) W. A. Web. Cladonia galapagosensis Ahti, Ann. Bot. Soc. 'Vanamo' 32(1):46. 1961.

Cladina polia (R. Sant.) W. A. Web. Cladonia polia (as "pohlia", orth. error) R. Sant., Ark. Bot. 30A(10): 15. 1952.

Heterodermia barbifera (Nyl.) W. A. Web. Physcia barbifera Nyl., Syn. Lich. 1:416. 1860.

Heterodermia circinalis (A. Zahlbr.) W. A. Web. Anaptychia leucomelaena var. multifida f. circinalis A. Zahlbr., Beih. Bot. Centralbl. 19(2):84. 1905.

Heterodermia stellata (Vain.) W. A. Web. *Anaptychia podocarpa var. stellata* Vain., Acta Soc. Fl. Faun. Fenn. 7:131. 1890.

Heterodermia verrucifera (Kurokawa) W. A. Web. *Anaptychia leucomelaena f. verrucifera* Kurokawa, Nova Hedwigia, Beih. 6:72. 1962.

VALIDATIONS OF NEW SPECIES

LECANORA PSEUDOPINGUIS W. A. Web., *sp. nov.* Thallus saxicolous crustaceus effusus indeterminatus rimoso-areolatus, areolis minus quam 1 μm diam ca. 0.5 mm crassis laevibus pallide citrinis vel albescentibus soredia et isidia desunt. Cortex 30 μm crassus, granulis lutescentibus inspersis, medulla fulvescens, C+ aurantiaca, P-, K-, IKI-, UV+ rubro-violascens. Apothecia sessilia usque ad 1.5 mm diam margine crasso laevi vel undulato-crenulato disco plano livido pulverulento, epihymenio flavo-granuloso C+ aurantiaco hymenio 50-60 μm crasso sporis 8/nae 7-9 x 3-5 μm. Pycnidia cylindrica 200 μm alta x 100 μm lata margine prominenti elevato, conidiis arcuatis acicularis 15-20 μm longis. Ad saxa vulcanica praecipue litoralis.

Thallus saxicolous, crustaceous, effuse, indeterminate, irregularly rimose-areolate with areoles less than 1 mm diam, ca. 0.5 mm thick, smooth, pale citrine to albescent, lacking soredia or isidia. Cortex 30 μm thick, inspersed with yellowish granules; medulla discolored, C+ orange, P-, K-, IKI-, UV+ red-violet. Apothecia sessile, up to 1.5 mm diam, with thick smooth or crenulate-wavy margin, the disk plane, livid, pulverulent; epihymenium with yellow granules, C+ orange; hymenium 50-60 μm high, spores 8/ascus, 7-9 x 3-5 μm; pycnidia cylindric, 200 μm deep x 10 μm wide, with prominent raised rim resembling the apothecial margin; pycnoconidia arcuate, acicular, 15-20 μm long. On volcanic rocks, primarily littoral.

HOLOTYPE. Ecuador. Galapagos Islands. Isla Santa Cruz, vicinity of Academy Bay, on exposed point along shore just east of Darwin Research Station, abundant on rocks just above high tide mark, 10 April 1976, Weber & Lanier, Lich. Exsicc. COLO No. 500 (COLO). Further distribution. Floreana I., Jervis I., Wenman I., S. Plazas Islet, Champion I., and probably on every island of the archipelago. One population has been found inland from the seacoast but on a seaward exposure: Santiago I., on rocks at rim of easternmost crater in the highlands, 400 msm, 10 May 1971, L. H. Pike 2112 (COLO L-55204). This is a most unusual occurrence and may be correlated with atmospheric conditions (upwelling of fog) peculiar to the site. *L. pseudopinguis* is one of the dominant species coloring the rocks of the shoreline yellow on many of the islands.

Except for its effuse thallus the new species resembles the lobate littoral Californian *Lecanora pinguis* Tuck. Dr. Chicita Culberson, to whom I am indebted for analyses of the chemistry of *L. pseudopinguis* and the next species, reported: "*L. pseudopinguis* contained a compound (R_f classes A4-5, B5, C4-5; spot color with 10% H_2SO_4 and heat is orange brown) in high proportion that is probably a xanthone pigment....We have seen this same pigment before in a sample from Ahmadjian that was also from the Galapagos Islands but that had been identified as *Buellia straminea.* The proportions of the minor products of Ahmadjian's sample were different from the *Lecanora,* and the *Lecanora* also contained a trace of thiophaninic acid and another unknown pigment (probably not a xanthone) that is common in lichens and that we have previously called "pigment SV-1".

LECANORA (Eulecanora) TEXANA W. A. Web., *sp. nov.* Prothallus destitutus. Thallus effusus indeterminatus laevis vel tartareus non- vel indistinctissime lobatus, usque ad 2 mm crassus, irregulariter rimoso-areolatus vel continuus, pallide flavus. Pseudocortex prosenchymaticus 30-40 μm crassus ex hyphis erectis, strato algarum 30-50 μm alto, continuo. Medulla densissima, alba, subtus fulvescens, K-, KC+ luteus. Apothecium immersum vel adnatum, usque ad 2 mm diam, margine vestigiali, excipulo proprio ex hyphis erectis parallelis, disco carneo, plano vel convexiusculo, epihymenio hyalino granuloso, granulis in K dissolvens, hymenio 50-60 μm alto, subhymenio ex hyphis verticalibus, hypothecio hyalino subtus algifero, ascis IKI+ coeruleis, paraphysibus simplicibus, 2 m diam, gracilibus, non capitatis, sporis 8-nae anguste-ellipsoideis rectis vel plus minusve curvatis, 10-14 x 4-5 μm. Pycnidium ostiolo aeruginoso loculo 200 μm diam, pycnoconidiis Eulecanoroideis acicularis, arcte curvatis vel sigmoideis, 10-15 x 0.5 μm. Ad saxa granitica, areas amplas rupium superficieram verticalibus tectus.

Prothallus lacking. Thallus effuse, indeterminate, smooth to tartareous, very distinctly if at all marginally lobate, up to 2 mm thick, irregularly rimose-areolate or continuous, pale yellow; pseudocortex prosenchymatous, 30-40 μm thick, of erect hyphae; algal layer 30-50 m high, continuous; medulla very dense, white, becoming discolored brownish below, K-. KC+ yellow wash. Apothecia immersed to adnate, up to 2 mm diam, the margin vestigial or represented by a few small bead-like remnants; proper exciple of erect parallel hyphae; disk flesh-colored, plane to slightly convex; epihymenium hyaline, granulose, the granules dissolving in K; hymenium 50-60 μm high, difficult to differentiate from subhymenium of vertical hyphae; hypothecium hyaline, with continuous or broken algal layer below; asci IKI+ blue; paraphyses simple, 2 μm diam, slender, not capitate; spores 8/ascus, narrowly ellipsoid, straight or somewhat curved, 10-14 x 4-5 μm. Pycnidia appearing as black dots on thallus surface, the ostiolar margin aeruginose, the loculus 200 μm diam; pycnoconidia of Eulecanora type, acicular, curved in a semicircle, 10-15 x 0.5 μm. On granite rocks, covering large areas of the vertical faces, rarely fruiting, but when fertile with clusters of apothecia in small plaques of the thallus.

HOLOTYPE. Texas, U. S. A. Gillespie Co. [not Llano as given on the label]: trail to "Balanced Rock", a granite dome rising above the surrounding plain, 4 mi n of Fredericksburg in the Texas "Hill Country"; abundant and dominant on vertical N-facing massive granite blocks, 29 April 1974, Weber, Lich. Exsicc. COLO No. 451 (COLO).

Lecanora texana is apparently closely related to *L. sulphurea* (Hoffm.) Ach., but the apothecium is pale from the beginning, never blackening. Dr. C. Culberson reported: "*L. texana* contained usnic acid, zeorin and a trace of atranorin. In addition there were two or three unidentified triterpenoids that are probably related to zeorin but which do not correspond to leucotylin or leucotylic acid (the only known compounds of this type in our collection). There is also a curious unidentified phenolic compound (R_f classes A3, B2-3, C5; spot color with 10% H_2SO_4 and heat is yellow). This may be a new lichen product."

PSORA CEREBRIFORMIS W. A. Web., *sp. nov.* Thallus terricola cretaceus tumulos hygroscopicos usque ad 5 cm diam formantes, squamulis dense aggregatis sed non imbricatis primo planis mox alte convexis rimosis marginibus revolutis. Cortex argillaceus pseudoparenchymaticus 50-60 m crassus, strato epinecroso crasso albo tectus. Stratum gonidialium continuum. Medulla alba solida crassa, coacto rhizo-hyphoso substrato affixo. Cortex et medulla K-, C-, KC-, P-, IKI-. Apothecia 1-2 mm diam atra marginalia convexa numerosa plerumque aggregata, excipulo ex hyphis parallelis pallide ferrugineo, ascis clavatis 30-40 m longis, sporis ellipsoideis (8)10-12(17) x 5-6 m. Epihymenium ferrugineum K+ vinosum C-, P-, IKI-.

Thallus terricolous, chalk-white, forming hygroscopic convex mounds up to 5 cm or more diam; squamules densely aggregated but not overlapping, up to 5 mm diam, at first plane but very soon highly convex, deeply cracked, with the margins rolled under. Cortex pale clay-colored, of pseudoparenchyma type, 50-60 m thick, covered by a thick white epinecral pruinose layer. Algal layer continuous. Medulla white, solid, thick, attached to the substrate by a rhizo-hyphal felt. Reactions K-, C-. KC-. P-. IKI-. Apothecia 1-2 mm diam, black, marginal, highly convex, abundant and often clustered; exciple of parallel hyphae, pale reddish-brown; asci clavate,30-40 m long; spores ellipsoid, (8)10-12(17) x 5-6 m; epihymenium reddish-brown, K+ vinose, C-, P-, IKI-.

HOLOTYPE. U. S. A. Colorado. Montrose Co.: on gypsum knolls, floor of Paradox Valley 4 mi E of Bedrock, 1,500 msm, 30 May 1960, Shushan, Anderson & Weber, Lich. Exsicc. COLO No. 24 (COLO).

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CULTURAL STUDIES ON PORIA CINERASCENS, P. RIVULOSA, AND P. SUBVERMISPORA

(Aphyllophorales, Basidiomycotina)

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ABSTRACT

The culture complex involving Poria cinerascens, P. rivulosa, and P. subvermispora is examined. Cultural descriptions are provided for each species. Although nearly identical, cultures of these three species can be separated by temperature studies, growth on cabbage extract agar, and microscopic characteristics.

INTRODUCTION

Sporophores of Poria cinerascens (Bres.) Sacc. et Syd., Poria rivulosa (Berk. et Curt.) Cke., and Poria subvermispora Pilát are distinct and easily identified by observing the hyphal systems and basidiospores (Lowe 1966). However, when grown in pure culture they are nearly indistinguishable. Nobles (1948) treated P. rivulosa (as P. albipellucida Baxter) and P. cinerascens together under one culture description. Later, Nobles (1965) and Stalpers (1978) distinguished these fungi on minor or variable characters.

Because of the difficulty in identifying these cultures, the importance of individual species of the complex in the decay of products, preservative-treated wood, and other wood forms cannot be assessed accurately. Duncan and Lombard (1965), in their summary report on Hymenomycetes associated with decay of wood products, report these fungi collectively as the Poria cinerascens complex. Thus, this study was undertaken to resolve the P. cinerascens culture complex.

MATERIALS AND METHODS

Cultures were grown at 25° C in the dark on 1.5% malt extract agar (MEA) in glass petri plates and were examined at weekly intervals.

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Cultures were grown also on 0.5% gallic acid agar (GAA), on 0.5% tannic acid agar (TAA) (Davidson et al., 1938), and on cabbage extract agar (CAB) at 25° C and measured at 7 and 14 days.

Cabbage extract agar was made from fresh cabbage because growth of these fungi on commercial media was not satisfactory. CAB is prepared as follows: Place 500 gm chopped, fresh cabbage in 1000 ml distilled water, cover, and bring to a boil. Simmer about 15 hours (over several days if necessary) and add about 1,000 ml distilled water during this time. Filter through cheese cloth and bring final volume of cabbage extract to 1000 ml. Add 20 gm agar, 2.5 gm diabasic sodium phosphate, 5 gm sodium chloride, and 10 gm Difco Bacto-peptone to the 1000 ml of cabbage extract and autoclave.

Unless otherwise indicated, all cultures studied are of polysporous origin. Monosporous isolates were obtained from fruiting in culture. Key patterns of 2-week-old cultures follow the format of Davidson et al. (1942). Species codes of 6-week-old cultures follow the format of Nobles (1965). Cultures are on deposit at the Center for Forest Mycology Research.

Sporophores associated with the cultures were previously identified by Drs. J. L. Lowe, R. L. Gilbertson, or M. J. Larsen. Although the sporophores were not reexamined by the author, dikaryotic-monokaryotic matings were done with all cultures studied. Cultures listed under each species had successful matings with one or more haploids of that species.

CULTURE DESCRIPTIONS

Poria cinerascens (Bres.) Sacc. et Syd., Syll. Fung. 16:161. 1902.

Growth characters: Growth on MEA rapid, plates covered in 1 wk; mats white, appressed, thin, subfelty, with a network of thin, radial strands, sometimes slightly raised and downy or felty at 2 wk, may develop small white balls of mycelium at 6 wk; margin even, appressed; odor none; agar discoloration none; not fruiting by 6 wk. Oxidase reactions at 1 wk on GAA moderately strong, mat 37-51 mm diam; on TAA strong, mat 12-26 mm diam. Optimum temperature 36° C (Fig. 1). Growth on CAB 0-trace at 1 wk.

Microscopic characters: Hyphae of advancing zone 6-8 μm diam, thin-walled, simple septate, branched, becoming thick-walled and scattered by 2 wk. Hyphae of submerged mycelium 2-4 μm diam, thin-walled, nodose septate, branched. Hyphae of aerial mat (a) similar to submerged hyphae except occasionally encrusted with hyaline crystals; (b) "binding hyphae" very slender, 0.5 μm diam, aseptate, richly branched, hyaline, nonstaining in phloxine, rare to abundant at 2 wk; (c) fiber hyphae (Fig. 2) 4-6 μm diam, thick-walled, walls thinning toward apex, aseptate, hyaline nonstaining in phloxine, apparently lacking or numerous at 2 wk. Chlamydospores globose to limoniform, 8-13.5 x 8-13.5 μm, thin-walled, walls thickening in age, hyaline, terminal or intercalary, few to abundant in aerial and submerged mycelium. Bulbils sometimes present in submerged mycelium.

Key patterns: A-P-F-1-2-10; A-P-F-1-2-10-16; A-P-F-1-2-11; A-P-F-1-2-11-16; A-P-F-1-2-10-14.

Species code: 2.4.(7).(8).(22).34.36.38.42.55.59.

Monosporous cultures: Eight monosporous cultures of HHB 76 (4 of each mating type) examined were similar to the polysporous cultures except that they did not have clamp connections.

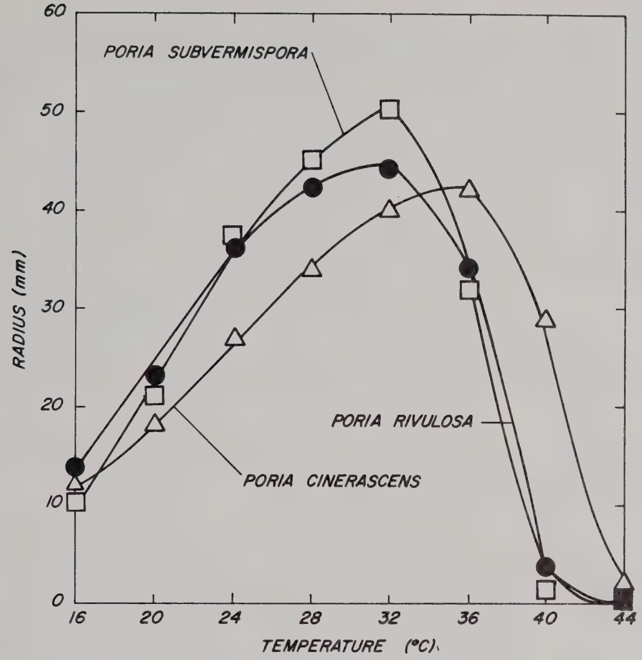
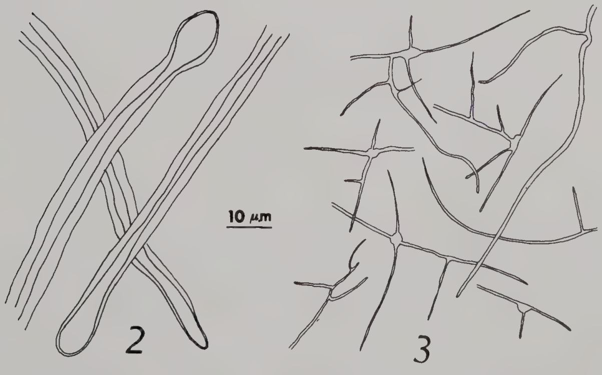


Fig. 1. Average radial growth of Poria species on MEA after 4 days at 8 temperatures. (M 149 135)



M 149 140

Fig. 2. Fiber hyphae from a culture of Poria cinerascens (FP 100506) at 2 wk.

Fig. 3. "Binding hyphae" from cultures of Poria rivulosa and P. subvermispora at 2 wk. (M 149 140)

Incompatibility system: *Poria cinerascens* has been reported by Nobles *et al*. (1957) to be heterothallic and bipolar. Pairing of 17 monosporous cultures of HHB 76 confirm their finding: A_1 = 1,4,5, 8,11,13,16,18; A_2 = 2,3,6,7,9,10,12,17.

Cultural description: Nobles (1948); Singh (1966).

Cultures studied: U.S.A.: MARYLAND--FP 100506 on pine, Prince Georges County; SOUTH DAKOTA--FP 105939 on *Pinus ponderosa* Dougl. ex Laws. (ponderosa pine), Black Hills National Forest; TEXAS--HHB 76 on *Pinus* sp., San Jacinto County; WISCONSIN--FP 105349 on *Pinus banksiana* Lamb. (jack pine), Wood County.

Remarks: The development of fiber hyphae and optimum temperature of 36° C are diagnostic for *P. cinerascens*. *Poria cinerascens* can quickly be separated from *P. rivulosa* and *P. subvermispora* by growing the cultures on MEA at 40° C (Fig. 1). At 4 days *P. cinerascens* grows significantly more than the other species. Cultures of *P. cinerascens* will often deteriorate after growing several years on artificial media. Deteriorated cultures are slow growing, sodden, and do not develop fiber hyphae.

Poria cinerascens is widely distributed in the U.S.A. and is associated with a white rot of conifers.

Poria rivulosa (Berk. et Curt.) Cke., Grevillea 14:109. 1886.

Growth characters: Growth on MEA rapid, plates covered in 1 wk; mats white, azonate, at 1 wk appressed, thin, subfelty, at 2 wk slightly raised, thicker, subfelty to felty; margin even, appressed; odor none; agar discoloration none; not fruiting by 6 wk. Oxidase reactions at 1 wk on GAA moderate, mat 64-90 mm diam; on TAA strong, mat 19-29 mm diam. Optimum temperature about 32° C (Fig. 1). Growth on CAB 20-48 mm diam at 1 wk.

Microscopic characters: Hyphae of advancing zone 6-7.5 mm diam thin-walled, simple septate, branched, by 2 wk often becoming thick-walled, rare to abundant, absent in older cultures. Hyphae of submerged mycelium 3-5 mm diam, thin-walled, nodose septate, branched. Hyphae of aerial mat (a) 1.5-5 mm diam, similar to submerged hyphae, sometimes encrusted with hyaline crystals; (b) "binding hyphae" (Fig. 3) very slender, 0.5 mm diam, aseptate, richly branched, hyaline, nonstaining in phloxine, usually present by 2 wk in clusters, difficult to separate. Chlamydospores globose to limoniform, 8.5-11.5 x 8.5-11.5 mm, thin-walled, becoming thick-walled in age, hyaline, terminal or intercalary, abundant in aerial mat.

Key patterns: A-P-F-1-2-10-16; A-P-F-1-2-10; A-P-F-1-2-10-14-16; A-P-F-1-2-10-14.

Species code: 2.4.(7).(8).34.36.38.41.42.55.59.

Monosporous cultures: Eight monosporous cultures of FP 133035 (4 of each mating type) were similar to the polysporous cultures except that thick-walled advancing zone hyphae were present in 6-wk-old cultures, and they lacked clamp connections and "binding hyphae."

Incompatibility system: Nobles *et al*. (1957) reported that *P. rivulosa* is heterothallic and bipolar. Pairings of 17 monosporous cultures of FP 133035 confirm their result: A_1 = 1,3,4,5,9,12,13,14,16, 17; A_2 = 2,6,7,8,10,11,18.

Cultural descriptions: Buckland (1946), Baxter (1937), and Nobles (1948) as *Poria albipellucida* Baxter; Stalpers (1978) as *P. lindbladii* (Berk. et Br. ex Berk.) Cooke.

Cultures studied: U.S.A.: CALIFORNIA--Piirto 26 (rot) in Sequoiadendron giganteum (Lindl.) Bucholz (giant sequoia); JLL 10602 on Sequoia sempervirens (D. Don) Endl. (redwood), Del Norte County; FP 104207 (rot) in redwood, Wilson Creek; IDAHO--JLL 6987 on conifer, Kootenai County; OREGON--FP 133035 (rot) in Tsuga sp., Benton County, FP 133406 and FP 133696 on conifer, Lincoln County. CANADA: BRITISH COLUMBIA--DAOM 9757 on Pseudotsuga menziesii (Mirb.) Franco (Douglas-fir).

Remarks: Poria rivulosa is most similar culturally to P. subvermispora. They can be separated, however, by growing the cultures on CAB. Poria rivulosa will grow 20-40 mm in diameter at 1 wk but P. subvermispora only 0-trace.

Poria rivulosa is common in the northwest U.S.A. and British Columbia on conifers. It is associated with a white ring rot of living western redcedar, Thuja plicata Donn ex D. Don (Buckland 1946) and living redwood (Kimmey and Lightle 1955).

Poria subvermispora Pilát, Studia Bot. Cech. 3:2. 1940.

Growth characters: Growth on MEA rapid, plates covered in 1 wk; mats white, azonate, at 1 wk appressed and subfelty or raised and downy, at 2 wk appressed, subfelty to felty, or raised and woolly, sometimes tufted; margin even, appressed; odor none; agar slightly bleached in age; not fruiting by 6 wk. Oxidase reactions at 1 wk on GAA moderate, mat 69-90 mm diam; on TAA strong, mat 22-30 mm diam. Optimum temperature 32° C (Fig. 1). Growth on CAB 0-trace at 1 wk.

Microscopic characters: Hyphae of advancing zone 6-7 μm diam, thin-walled, simple septate, infrequently branched, by 2 wk becoming thick-walled, rare. Hyphae of submerged mycelium 2-4 μm diam, thin-walled or with slight wall thickening, nodose septate, branched. Hyphae of aerial mat (a) similar to submerged hyphae, occasionally encrusted with hyaline crystals; (b) "binding hyphae" very slender (Fig. 3), 0.5 μm diam, aseptate, richly branched, hyaline nonstaining in phloxine, usually present in clusters by 2 wk, difficult to separate; (c) fiber hyphae rare, 2 μm diam, thick-walled, aseptate, hyaline nonstaining in phloxine, infrequently branched, seen only in 6-wk-old cultures of FP 90031. Chlamydospores globose to limoniform, 11.5-13.5 (-16) x 7.5-13.5 (-16) μm, thin-walled, walls thickening in age, hyaline, terminal or intercalary, numerous in submerged and aerial mycelium.

Key patterns: A-P-F-1-2-10-16; A-P-F-1-2-10; A-P-F-1-2-10-14-16; A-P-F-1-2-10-14.

Species code: 2.4.(7).(8).34.36.38.41.(42).54.55.59.

Monosporous cultures: An examination of 8 monosporous cultures obtained from JLL 14807 (4 isolates of each mating type) reveals that they are similar to the polysporous isolates except that their mats tend to be appressed, develop delicate radial to reticulate patterns, and lack clamp connections.

Incompatibility system: Nobles et al. (1957), as P. notata Overh., and Domański (1969), as Fibuloporia subvermispora (Pilát) Domań., reported that P. subvermispora is bipolar. Pairings of 17 monosporous cultures of JLL 14807 confirm their results: A_1 = 1,3, 4,5,9,12,13,15,16,18,19; A_2 = 7,8,10,11,14,17.

Cultural descriptions: Baxter (1947) (as P. quercuum Baxter); Nobles (1948); Domański (1969); Stalpers (1978).

Cultures studied: U.S.A.: ARIZONA--JLL 8904 on ponderosa pine, Cochise County; COLORADO--JLL 6133 on conifer, Garfield County; JLL 6332 on lodgepole pine, Larimer County; FLORIDA--FP 104027 (sporophore tissue) on Quercus laurifolia Michx. (laurel oak), Duval County; MARYLAND--FP 90031 on oak and FP 105752 on hardwood board, Prince Georges County; NEW YORK--JLL 3292 on conifer, Essex County; JLL 15225 on hardwood, Ulster County; OREGON--ME 485 (rot) in Douglas-fir wood chips, Clatsop County. CANADA: Saskatchewan--JLL 14807 on Populus tremuloides Michx. (aspen).

Remarks: Poria subvermispora is widely distributed throughout continental U.S.A. It is associated with a white rot of conifers and hardwoods and has been isolated several times from wood chip piles in Washington and Oregon.

DISCUSSION

Cultures of P. cinerascens, P. rivulosa, and P. subvermispora can be identified by noting several critical characters. These are summarized in Table 1. Dikaryotic-monokaryotic pairings can be used also to identify cultures once monosporous cultures are obtained. Cultures of the three species will fruit on MEA and discharge spores if kept long enough. The shape and size of the basidiospores can also be used to differentiate between the species (Table 1).

Development of the slender "binding hyphae" found in the aerial mat of all three species has not been recorded previously. Their development in culture suggests their presence in the sporophore; however, this is not the case. Poria rivulosa and P. subvermispora have monomitic hyphal systems (Lowe 1966). However, Poria cinerascens sporophores have a trimitic hyphal system (Lowe 1966), and this is supported in culture.

Table 1.--Characteristics that differentiate cultures of Poria cinerascens, P. rivulosa, and P. subvermispora

	Optimum growth temperature	Growth at 40° C[1]	Growth on CAB[2]	Host	Basidiospore size[3]
	°C	mm	mm		µm
Poria cinerascens	36	30 - 36	0-trace	Conifers	4.0 - 7.0 x 1.5 - 2.0
P. rivulosa	32	1 - 7	20 - 48	Conifers	5.0 - 6.0 x 4.0 - 5.0
P. subvermispora	32	1 - 2	0-trace	Conifers and hardwoods	3.5 - 6.0 x 1.0 - 1.5

[1] Average radial growth after 4 days on malt extract agar.

[2] Average mat diameters on cabbage extract agar after 7 days at 25° C.

[3] Spore measurements taken from Lowe (1966).

Culturally, these three species belong to a unique group of fungi. The rapid growth, production of extracellular oxidases, simple septate hyphae of the advancing zone that later give rise to nodose septate hyphae, and the bipolar mating system are characters shared by all species of Group 54 (Nobles 1958). Phlebia subserialis (Bourd. et Galz.) Donk, Phlebia subochracea (Bres.) Erikss. et Ryv., and Hyphodontia setulosa (Berk. et Curt.) Maas G. are the most culturally similar to the Poria species discussed.

ACKNOWLEDGMENTS

Ms. Ruth G. Payne is responsible for the successful development and application of the cabbage extract medium. Critical reviews of this manuscript by Drs. R. L. Gilbertson, H. H. Burdsall, Jr., and Mrs. F. F. Lombard are greatly appreciated.

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A NEW SPECIES OF *AMANITA*

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ABSTRACT

Amanita marginata (fig. 1) is described as new from Tennessee. It is assigned to Section *Lepidella*, Subsection *Solitariae*.

Amanita marginata Jenkins, sp. nov.
Holotype: Tennessee, Loop Road, Cades Cove, Great Smoky Mountains National Park, 17. viii. 72, David T. Jenkins 580(DTJ).*

Pileus 110 mm mense diametro, convexus, margo leviter appendiculatus, non striatus; labrum distinctum sterileque subter, album convertens ad gilvum colorem; reliquae volvae ita verrucae adnatae factaeque in inaequalem formam, gilvae cum cacumenibus in vero colore, potius in circlos qui easdem medias partes habent. Lamellae stipatissimae, solutae. Stipes 90 x 20 mm, solidus, fibrillosus squameusque adversus basem; tegumen ad apicem partim, pendens, album, delicatum; bulbus ad basem in ovi formam factus, gilvus; maculans flammeus fuscusque adversus fundum; aliquando rimae longitudine; reliquae volvae ita circli squamarum adnatarum reflexarumque leviter, qui easdem medias partes habent. Sporae 5.46-6.25 x 7.0-10.15 µm.

Fruit body medium to large, solitary. PILEUS: 110 mm diam, convex, margin non-striate, very slightly appendiculate, but with a distinct, sterile margin, up to 3 mm wide, pileipellis fairly easily separable, fibrillose between volval remnants, white to creamy-white, flesh white, up to 15 mm thick at center, tapering toward margin; universal veil remnants as fibrous, adnate, irregular-shaped warts, up to 7 mm wide at base, cream with tips cream to pale tannish-cream, more or less concentric ring arrangement, becoming decidedly smaller toward margin. LAMELLAE: very crowded, free, fairly broad, cream, edges smooth; lamellulae numerous, attenuate. STIPE: 90 x 20 mm, solid, white, fibrillose-scaly beneath annulus, becoming lacerate-scaly toward base; partial veil apical, creamy-white, pendant, large and thick, striate above, floccose below, double-edged, very delicate, soon falling off, ring of universal veil material approximately 10 mm below partial veil. Basal bulb ovoid, cream at apex, staining orangish-brown toward bottom, 65 x 45 mm, occasionally with longitudinal splits; universal veil remnants as concentric rings of adnate, slightly recurved scales, quite thick, on upper part of bulb. Faint chloride of lime smell.

PILEIPELLIS: filamentous hyphae densely interwoven, slightly gelatinized, hyaline, 2-7 µm diam. PILEUS TRAMA: filamentous hyphae undifferentiated, moderately branched, clamps rare, 3-8 μm diam; inflated cells abundant, mostly terminal, variform, mostly elongate, up to 162 x 31 μm. LAMELLA TRAMA: bilateral; filamentous hyphae undifferentiated, moderately branched, no clamps, 3-8 μm diam; inflated cells terminal, elongate. SUBHYMENIUM: hyphae ramose, clamps rare. BASIDIA: up to 48 x 3.9-8.6 μm, 4-sterigmate, thin walled, without clamps. UNIVERSAL VEIL: filamentous hyphae on pileus moderately abundant, sparsely to moderately branched, without clamps, 3-6 μm diam, irregularly disposed; inflated cells abundant, globose, subglobose, broadly elliptic, elliptic, clavate, cylindric, most being quite small, not exceeding 62 x 46 μm, usually short, terminal chains, irregularly disposed: tissue on basal bulb similar, but with a slightly higher percentage of filamentous hyphae. STIPE TRAMA: filamentous hyphae undifferentiated and abundant, sparsely branched, without clamps, 3-6 μm diam; the presence of gloeoplerous hyphae conspicuous; inflated cells terminal, clavate, longitudinally oriented, up to 312 x 25 μm. PARTIAL VEIL: upper surface mostly inflated cells, elliptic, ventricose, clavate, up to 125 x 63 μm, mostly terminal; filamentous hyphae sparse, sparsely branched, without clamps, 2-7 μm diam: lower surface similar to that above, but with many more smaller inflated cells, variform; filamentous hyphae also sparse, similar to above.

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* DTJ = The author's herbarium

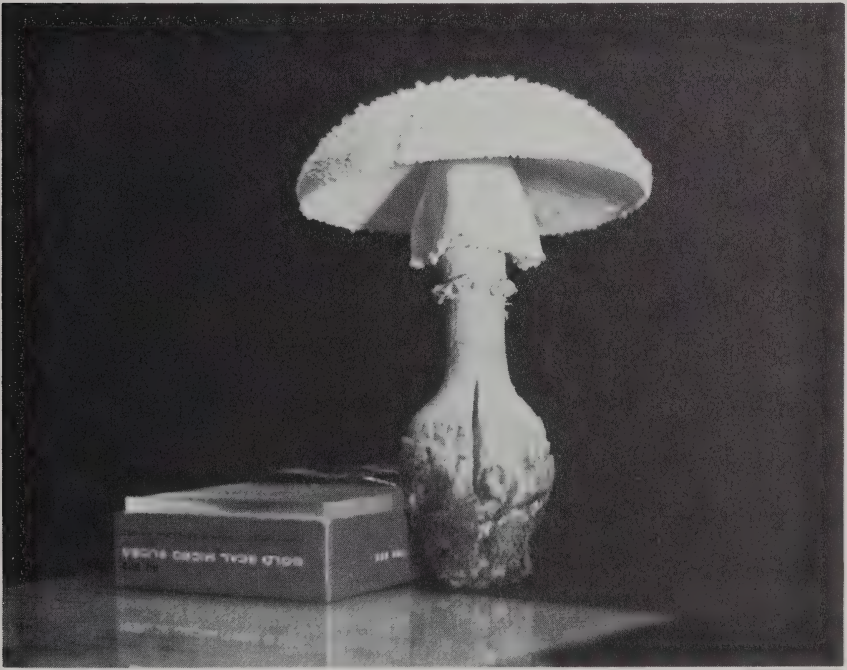

Fig. 1 *Amanita marginata* Jenkins 580(DTJ)

SPORES: 5.46-6.25 x 7.0-10.15 µm, ($\underline{E}$ - 1.25-1.62; $\underline{E}^m$ - 1.51), elliptic to elongate, adaxially flattened, thin walled, hyaline, weakly amyloid, spore print white; contents guttulate; apiculus sublateral, short cylindric.

Habitat and distribution: terrestrial, mixed coniferous and deciduous forest, Tennessee.

Collections examined: road cut, Loop Road, Cades Cove, Great Smoky Mountains National Park, Tennessee, 17. viii. 72, David T. Jenkins 580(DTJ).

Discussion: *Amanita marginata* is assigned to Section *Lepidella*, subsection *Solitariae*. This is due to the presence of such characters as amyloid spores, an appendiculate pileus margin, a white to cream pileus color, and variform volval elements.

As attempt has also been made to assign this organism to a particular stirps. Following the organization of Bas (1969) this organism would seem to belong to Stirps *Strobiliformis*, based upon the absence of basidial clamps, white volval remnants with moderately abundant, interwoven elements, and the production of irregularly shaped volval warts on the pileus.

Although this organism is apparently related to the members of Stirps *Strobiliformis*, only slight changes in a particular character would allow it to fit into other stirps. For example, if the basidia had clamps this organism could be placed into Stirps *Virgineoides* due to its small to medium, detersile volval warts and the irregularly disposed universal veil remnants, consisting of moderately abundant hyphae and inflated cells. If the elements of the volval remnants on the pileus had a more erect-parallel disposition, it would be more closely related to Stirps *Polypyramis*, due primarily to its color and small to medium, detersile warts.

As the *Amanita* flora of the United States, and in particular the southeastern region, is further studied the variation and diversity becomes increasingly apparent. As can be seen with *Amanita marginata* it is frequently quite difficult to determine the specific relationship with other members of this section based upon the current classification system. Therefore, the establishment of new stirps within this section may be necessary in the future.

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CANDIDA PARATROPICALIS, A NEW SPECIES OF CANDIDA

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An unusual *Candida* isolated from clinical specimens has been found to be sufficiently different from existing taxa within this genus to warrant its establishment as a new species, *C. paratropicalis*.

MATERIALS AND METHODS

Twenty-nine isolates of the new *Candida* were recovered from specimens of human blood, sputa, urine, bronchial washings, throat swabs, a lung biopsy, and a decubitus ulcer. Their morphologic and physiologic characters were studied by procedures previously described (Baker, Salkin, Pincus, and D'Amato, 1981a, b).

TAXONOMIC PART

Division: Fungi imperfecti.
Form class: Blastomycetes.
Form order: Cryptococcales.
Form family: Cryptococcaceae.

Candida paratropicalis Baker, Salkin, Pincus et D'Amato, sp. nov. (Figure 1).

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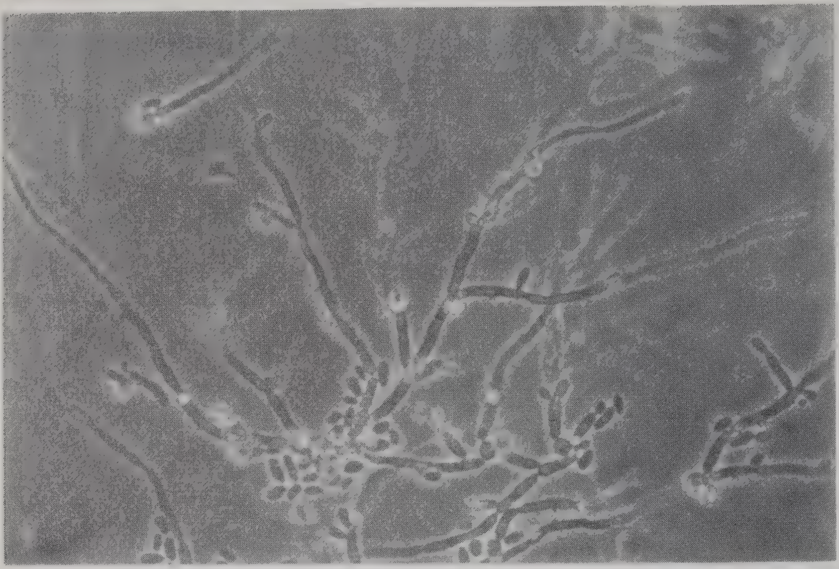

Fig. 1. *Candida paratropicalis* on cornmeal + 1% Tween 80 agar after 7 days incubation at 25°C.

Coloniae in extracti malti agaro cultae 2 mm diam usque sunt, ochroleucae farinulentae, lucidae vel sublucidae, planae subconvexae vel umbonatae, marginibus filamentosis patulis. Per dies 14 in glucoso-fermenti extracto cum aqua peptonica immersis sedimentum pelliculumque formantur, cellulis fertilibus ovoideis vel elongato-ovoideis (2.5--7.5 x 3.0--12.5 µm) cum quibus blasticonidia gemmantia numerosa collo angusto conjunguntur; pseudohyphae hyphaeque genuinae adsunt. In farinae Zeae agaro per dies 7 cultae fermenti cellulae ovoideae vel elongato-ovoideae (2.5--6.5 x 3.5--14.0 µm) cum pseudohyphis hyphisque genuinis formantur. Status sexualis ignotus. Notulis physiologicis (tab. 1) cum *C. tropicalis* (Cast.) Berkhout congruit, sed sucrosum melezitosum fermentare necnon L-arabinosum assimilare nequit simulque methyl-D-glucosidum sucrosum melezitosumque modo variabili assimilat.

Habitat: Man.
Holotype: 79MR8, isolated from human blood at autopsy, New York, New York.

The holotype slide preparations, as well as living cultures, have been deposited in the American Type Culture Collection, Rockville, Maryland (accession number ATCC 42678), and in the New York Botanical Garden Culture Collection, Bronx, New York.

The epithet *C. paratropicalis* was chosen to emphasize the resemblance of this species to *C. tropicalis*.

Colonies on malt-extract agar at 14 days are 2 mm in diameter; yellowish-white; pasty; glossy to dull glossy; and umbonate, flat, or slightly convex, with spreading filamentous margins. At 14 days in glucose -- yeast-extract -- peptone water a sediment and pellicle have formed; reproductive cells are ovoid to long-ovoid (2.5-7.5 x 3.0-12.5 µm) with multiple budding blastoconidia, each attached by a narrow neck; and pseudohyphae and true hyphae are present. When grown on cornmeal agar for 7 days, the cells are ovoid to long-ovoid (2.5-6.5 x 3.5-14.0 µm) with well-ramified pseudohyphae and true hyphae. The teleomorph is unknown. Physiologic characters (Table 1) are similar to those of C. *tropicalis* (Cast.) Berkhout except for (i) the inability of C. *paratropicalis* to ferment sucrose and melezitose and assimilate L-arabinose and (ii) its variable assimilation of methyl-D-glucoside, sucrose, and melezitose.

DISCUSSION

The morphology of C. *paratropicalis* (shape and size of blastoconidia, development of blastoconidia in sparse clusters at hyphal nodes, absence of chlamydospores and germ tubes) suggests a close similarity to C. *tropicalis* and its sucrose-negative variant (Ahearn, Meyer, Mitchell, Nicholson, and Ibrahim, 1977; Baker et al., 1981a). However, the new species' inability to ferment sucrose and melezitose clearly differentiates it from C. *tropicalis* (van Uden and Buckley, 1970). The utilization of methyl-D-glucoside, melezitose, and sorbose by many isolates of C. *paratropicalis* (24%, 52%, and 90% respectively; Baker et al., 1981a) and its inability to assimilate inulin distinguish this taxon from the sucrose-negative form of C. *tropicalis* (Ahearn et al., 1977).

Since isolates of C. *paratropicalis* frequently (41%) do not assimilate sucrose, cursory examination of such isolates could contribute to their misidentification as C. *stellatoidea*.

The lack of recognition of this new species despite its relative frequent recovery from diverse clinical specimens in several laboratories suggests that C. *paratropicalis* has been and probably still is being misidentified.

ACKNOWLEDGMENTS

The authors express their appreciation to Dr. Rupert Barneby for preparation of the Latin translation of the diagnosis, to Drs. G. A. Land and G. D. Roberts for supplying some of the cultures used in this study, and especially to Dr. Michael R. McGinnis for providing taxonomic assistance.

TABLE 1. FERMENTATION AND ASSIMILATION PATTERNS OF 29 *C. paratropicalis* ISOLATES[a]

Substrate	Isolates positive (%)	
	Fermentation	Assimilation
Cellobiose	0	69
Dextrose	100	100
Galactose	100	100
Inulin	0	0
Lactose	0	0
Maltose	100	100
Melezitose	0	52
Melibiose	0	0
Raffinose	0	0
Sucrose	0	59
Trehalose	100	100
D-Arabinose		0
L-Arabinose		3
Citric acid		100
Dulcitol		0
Erythritol		0
Ethanol		100
Ethylamine hydrochloride		100
Glucitol		100
Glycerol		14
Inositol		0
2-Keto-gluconate		100
DL-Lactic acid		86
Mannitol		100
Methyl-D-glucoside		24
Potassium nitrate		0
Ribitol		100
Ribose		10
Rhamnose		0
Salicin		24
Sorbose		90
Succinic acid		100
Xylose		100

[a] Results obtained with Wickerham broth technique at 3 weeks.

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MYCOTAXON

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NOTES ON CORTICIACEAE (BASIDIOMYCETES) VIII.

Two new species of Tubulicrinis.

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SUMMARY

Tubulicrinis cinctoides and T. ovalisporus are described from North Europe and Africa respectively. The first species is similar to T. cinctus G.H.Cunn. but delimited by its more globose spores and cystidia of divergent appearance. The African species is related to the T. glebulosus-group in its cystidial morphology, but well defined by having oval spores. The type of T. cinctus was studied.

TUBULICRINIS CINCTOIDES Hjortst. nov. spec. Fig. 1,a-c.

Species Tubulicrini cincto affinis sed sporis oblique subglobosis (4.75-)5 x (3.75-)4-4.5 um; lyocystidiis indistincte capitatis, 60-70(-90) x 5-6 um.

Holotypus: Sweden. Östergötland. V. Tollstad par., Omberg, Storpissan state forest reserve, in herb-rich Picea forest, on decayed trunk of Picea abies. 1979-11-09. K.Hjortstam & T.Hallingbäck. Hjm 11348 (GB).

Paratypus: do. Hjm 11393 (priv.herb.).

Fruitbody resupinate, effuse, at first reticulate, then more or less continuous, thin, whitish, with the cystidia projecting, each with a globule of excreted matter easily seen under a lens (50-100 X).
Subiculum very sparse, composed of thin-walled, more or less uniform hyphae, about 2-2.5 um wide, with a clamp at each septum.
Lyocystidia faintly amyloid, mostly greyish in Melzer´s reagent, cylindrical, up to 60-70(-90) um long and 5-6 um wide near the bi-, seldom tri-furcate base; the capillary lumen ending more or less abruptly; neck-width (3.5-)4-5 um, the apices of the cystidia slightly expanded but indistinctly capitate, usually not more than 6-7 um in diam.
Basidia small, 12(-15) x (4.5-) 5 (-6) um, with four sterigmata and a clamp at the base, not amyloid.
Spores obliquely subglobose, thin-walled, with neither amyloid nor cyanophilous reaction, (4.75-) 5 x (3.75-) 4-4.5

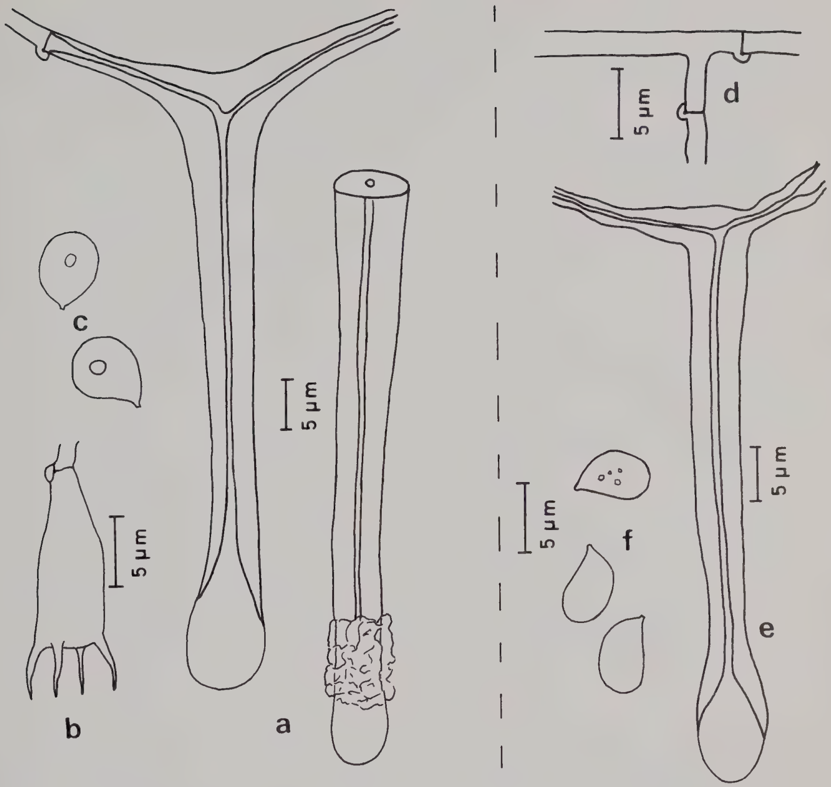

Fig.1. Tubulicrinis cinctoides a) cystidia b) basidium c) spores. - Coll. Hjm 11348 (holotypus). T. cinctus d) hypha e) cystidium f) spores. - Coll. Cunn. 17428 (holotypus).

um, with a distinct apiculus.

Remarks. The new species T. cinctoides is undoubtedly very similar to T. cinctus G.H.Cunn. but seems to be well delimited by its more globose and slightly larger spores. In the type of the latter (as far as known the only material gathered) the spores are more or less ellipsoid and measure 4.2-4.5 (-5) x 2.75-3.25 (-3.5) um (in the original description 4-4.5 x 3-3.5 um), while most spores of T. cinctoides measure 4.75-5 x 3.75-4 um. The lyocystidia of the two species show a slight but clear difference. In T. cinctus the apical bulb is fairly distinct, starting somewhat abruptly from the neck (fig.1,e), and thick-walled in the basal part, while the cystidial-bulb of the new species is less marked and usually consists only of the thin-walled part of the apex (fig.1,a).

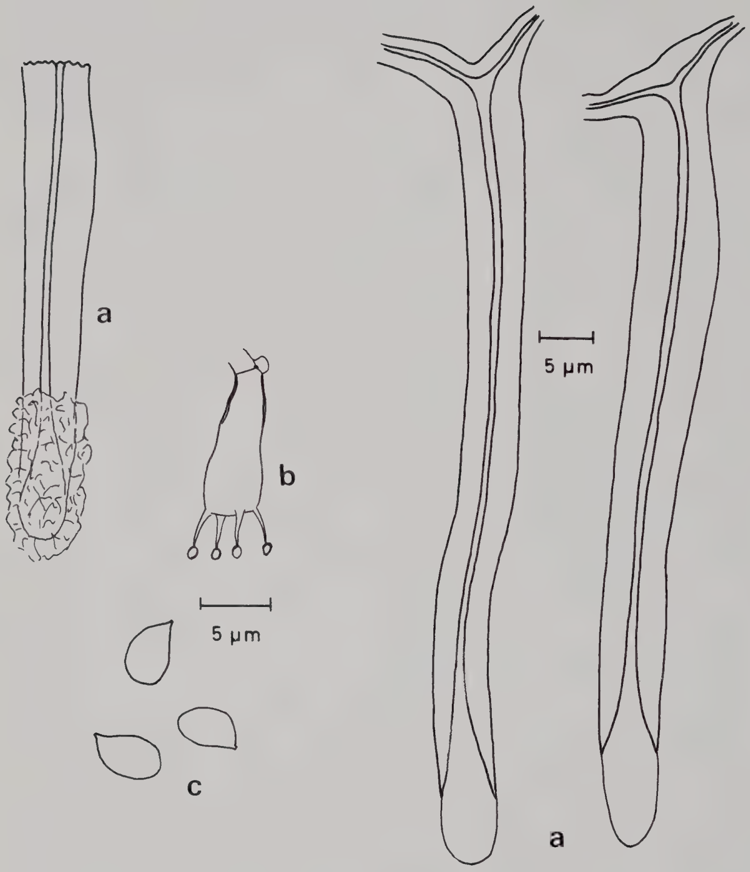

Fig.2. Tubulicrinis ovalisporus a) cystidia b) basidium c) spores. - Coll. Ryv. 11308 (holotypus).

TUBULICRINIS OVALISPORUS Hjortst. nov. spec. Fig. 2.

Species Tubulicrini glebuloso affinis sed fructificatione subtiliter odontioide et sporis ovalibus 4.5 (-5) x 2.5-2.75 (-3) um; lyocystidiis cylindricis, pallide amyloidibus (fere griseis), circiter 100 x 5-6 um, versus apicem leviter angustum.

Holotypus: Africa. Malawi. Southern Prov., Mulanje distr., Mulanje Mts., Lichenya Plateau, alt. 1800-2000 m.a.s.l., on coniferous wood, probably Widdingtonia. 1973-03-09/10. L. Ryvarden 11308 (O). Isotypus: in GB.

Paratypus: do. L. Ryvarden 11382 (O).

Fruitbody resupinate, effuse, thin, composed of very small aculei, about 15-20/mm, whitish or becoming yellowish brown, with numerous cystidia projecting above the hymenium and easily observed under a lens (50-100 X), each encrusted at the apex with brownish, excreted material.
Subiculum thin, mostly inconspicuous, composed of thin-walled, uniform hyphae with clamps, usually 2-3 um wide.
Lyocystidia numerous, cylindrical, faintly amyloid, about 100 um long and 5-6 um wide near the bi-furcate base, tapering slight towards the apex and with a neck-width of 4-5 um, the capillary lumen ending gradually at the slightly tapering, but obtuse, apical part.
Basidia usually 13-15 x 4.5-5 um, with four sterigmata and with a basal clamp, not amyloid.
Spores ovate or ellipsoid, thin-walled, 4.5 (-5) x 2.5-2.75 (-3) um, with neither amyloid nor cyanophilous reaction.

Remarks. Owing to the cystidial morphology this new species seems to be closely related to T. angustus (Rog.& Weres.) Donk and T. glebulosus (Bres.) Donk but is distinguished by its ovate to ellipsoid spores. The finely odontioid fructification is somewhat unusual in other species of the genus, but recently Jülich described one species (T. corneri) which, according to the description, is quite close to T. hamatus (Jacks.) Donk but distinctly toothed, with fairly large aculei. In fresh material, similar growth structure can be demonstrated for example in T. inornatus (Jacks. & Rog.) Donk,where it is less pronounced than in T. ovalisporus.

Acknowledgement

The author is grateful to Carl Stenholm's foundation for supporting the investigation of the Storpissan nature reserve. In a subsequent paper the region of Omberg will be treated more thoroughly.

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NOTES ON CORTICIACEAE (BASIDIOMYCETES) IX.

Three new combinations in Hypochniciellum.

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SUMMARY

The genus Hypochniciellum with the type species Leptosporomyces ovoideus Jülich was described by Hjortstam and Ryvarden (1980) and characterized by pellicular to membranaceous fruitbodies and thick-walled, cyanophilous spores.
Three new combinations are proposed here: H. cremeoisabellinum, H. molle, and H. subillaqueatum. The generic circumscription is slightly emended to include also species with spores greyish but not distinctly blue in Melzer´s reagent.

INTRODUCTION

When Eriksson and Ryvarden (1976) treated the genera Leptosporomyces and Leucogyrophana they discussed several similarities between Leptosporomyces ovoideus Jülich and Leucogyrophana cremeoisabellina (Litsch.) Parm., L. mollis (Fr.) Parm., and L. subillaqueata (Litsch.) Jülich. The authors also expressed the possibility of joining the species in a separate genus.

Later on Ginns (1978) circumscribed the genus Leucogyrophana and excluded the three species mentioned above without any suggestions as to their generic position. Consequently, the species need a place in the family Corticiaceae, and in my opinion Hypochniciellum seems to be suitable.

Without any doubt the thickness of the spore-wall is a character to consider, uniting the species. In spite of the fact that the spores of H. ovoideum are non-amyloid in comparision with the other species, which have a more or less greyish reaction, the species have many characters in common

The genus Amyloathelia Hjortst. (1979) is in many respects not appropriate for the species here referred to Hypochniciellum. All species in that genus have strongly amyloid spores and thinner spore-walls.

Key to the species of *Hypochniciella*m

1. Cystidia present, basal hyphae with thickened walls, about 5-6 um wide.................... *H. molle*
1. Cystidia absent, basal hyphae thin-walled up to 4-5 um wide........................... 2

2. Spores 5-6 (-7) um long..................... *H. cremeoisabellinum*
2. Spores 3.5-4.5 (-5) um long................. 3

3. Spores unchanged in Melzer´s reagent. Known only from deciduous wood.................... *H. ovoideum*
3. Spores greyish in Melzer´s reagent. Known only from coniferous wood.................. *H. subillaqueatum*

HYPOCHNICIELLUM Hjortst. & Ryv., Mycotaxon 12(1): 176, 1980.

Type species: *Leptosporomyces ovoideus* Jülich

Emendation.

Fruitbody resupinate, effuse, pellicular to membranaceous, with a whitish, fairly well-developed subiculum, consisting of loosely interwoven hyphae; hymenium smooth or with small granules; margin inconspicuous or in some species fibrillose to rhizomorphic.
Hyphal system monomitic. Basal hyphae thin-or more or less thick-walled, subhymenial hyphae thin-walled, all hyphae with clamps.
Cystidia present or absent, somewhat hypha-like, with thin- or thickened walls.
Spores thick-walled, cyanophilous, in some species with walls greyish in Melzer´s reagent.

HYPOCHNICIELLUM CREMEOISABELLINUM (Litsch.) Hjortst. nov. comb. Basionym: *Corticium cremeoisabellinum* Litsch., Ann. mycol. 39(2-3): 117, 1941.

Lectotypus: Sweden. Södermanland. Near Saltsjöbaden, on Pinus sylvestris. 1906-11-14. L. Romell (S). !

This is a little-known species, but during recent years a few collections have been found in Norway. One of these specimens (Hjm 10530), differs in having spores greyish in Melzer´s reagent and in having slightly encrusted hyphae. It is possible that the species consists of more than one taxon but this cannot at present be satisfactorily solved.

Selected specimens studied: Sweden. Småland. Rumskulla par., Norra Kvill Nat. Park, on coniferous wood. 1970-10. Gro Gulden s.n. (GB and O). Norway. Oppland. Dovre. Hjerkinnholen, elev. 950 m, on Pinus sylvestris. 1979-08-25. Hjortstam 10497; do. Hjm 10530 (both in Hjm priv. herb.).

HYPOCHNICIELLUM MOLLE (Fr.) Hjortst. nov. comb.
Basionym: *Thelephora mollis* Fr., Syst. mycol. I, pag. 443, 1821.

Authentic material not located.

The modern interpretation of the species corresponds well with the protologue by Fries which reads as follows: effuse, carnoso-membranacea, rubescenti-pallida, subtus tomentosa, papillis prominulis majusculis.

On well-developed specimens the small granules (which were observed by Fries) on the hymenium are easily distinguishable, at least under a lens (50 X), and together with the cystidia, spores, and wider basal hyphae with thickened walls, delimit the species well from others of the genus.

Selected specimens studied: Sweden. Västergötland. Bergstena par., Korpås, on decayed timber (coniferous wood). 1977-08-07. Hjortstam 8141. Norway. Akershus. Nannestad. Tømte farm, on coniferous wood. 1978-09-27. Hermansen & Hjortstam s.n. (both in Hjm priv. herb.). Hedmark. Grue. Meldalen, on Picea abies. 1974-10-12. L. Ryvarden 13352 (O).

HYPOCHNICIELLUM SUBILLAQUEATUM (Litsch.) Hjortst.,nov. comb. Basionym: Corticium subillaqueatum Litsch., Ann. mycol. 39 (2-3): 128-129, 1941.

Lectotypus: Sweden. Stockholm. Lidingö, on Pinus sylvestris. 1910-05-29. L. Romell 2068 (S). !

For a good description and comprehensive discussion of the species see Eriksson and Ryvarden 1976.

Selected specimen studied: Sweden.Uppland. Ärentuna par., Storvreta, on decayed coniferous fencing. 1927-05-08. Seth Lundell No. 53 (GB).

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CLADOSPORIUM BANTIANUM AND ITS SYNONYM *CLADOSPORIUM TRICHOIDES*

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SUMMARY

Examination of the type material for *Cladosporium bantianum* (Sacc.) Borelli and the living type culture of *C. trichoides* Emmons, as well as a number of other living cultures, has revealed that these two taxa are conspecific. Based upon priority, *C. bantianum* is the correct name for this taxon.

INTRODUCTION

During the past several years, there has been considerable controversy regarding *Cladosporium bantianum* (Saccardo) Borelli, 1960 and its relationship to *C. trichoides* Emmons, 1952. Borelli (4) studied the type material for *Torula bantiana* Saccardo, 1912, which was isolated from a human case of cerebral phaeohyphomycosis by Banti (1), and concluded that *T. bantiana* should be transferred to the genus *Cladosporium*, for which, he proposed the new combination *C. bantianum*. Borelli also considered *C. trichoides*, which was likewise isolated from a case of human cerebral phaeohyphomycosis (3), to be a synonym of *C. bantianum*. Emmons *et al.* (5) have disagreed with Borelli. They consider *C. trichoides* to be a distinct species and *Torula bantiana* a *nomen confusum*. This study was undertaken to reevaluate these two taxa and to resolve the controversy surrounding *C. bantianum* and *C. trichoides*.

METHODS AND MATERIALS

Living cultures were studied on potato dextrose agar (PDA) after 2 weeks incubation at 25°C in the dark. Measurements were determined from camera lucida drawings of slide culture preparations.

Herbarium specimens examined. Exsiccatum labelled 499, *Torula bantiana* Sacc., Herbarium Mycol. Orto Botanico, Padova, Italy, P. A. Saccardo; 5 photomicrographs of *T. bantiana* prepared by P. A. Saccardo; DMD-38, slide culture preparation grown on PDA, isolated from sawdust mulch heap via spleen tissue of hamster, Williamsburg, VA, prepared by D. Dixon in 1977, received as *C. trichoides* (see NCMH 1145 for living culture); DMD-39, slide culture preparation grown on PDA, isolated from sawdust mulch heap via testes of hamster, Williamsburg, VA, prepared by D. Dixon in 1977, received as *C. trichoides* (see NCMH 1148 for living culture).

Living cultures of *C. bantianum* studied. NCMH 111 = CDC B-1937 = NIH 8595 = IP 509, from human brain abscess, sent to NIH by G. Segretain, Institut Pasteur, Paris; NCMH 112 = CDC B-1938 = NIH 8580, from human brain abscess, T. Collette, Sayre, PA.; NCMH 113 = CDC B-1940 = NIH 8579 = ATCC 10958 = CBS 173.52, type culture, from human brain abscess, C. Binford, Baltimore, MD; NCMH 114 = CDC B-1941 = NIH 8598, from soil, P. Klite *et al.*, Panama; NCMH 115 = CDC B-2003 = NIH 8504, from chronic abscess in human abdominal wall, J. Pereira, Washington, DC; NCMH 116 = NCMH 121 = CDC B-2283 = CDC B-1897, from brain abscess in a cat, S. Jang *et al.*, Davis, CA; NCMH 117 = CDC A-980 = NIH 8590, from human brain abscess, J. Barnola Duxans, Caracas, Venezuela; NCMH 121 = NCMH 116 = CDC B-1897, from brain abscess in a cat, M. Rinaldi, Davis, CA; NCMH 122 = CDC B-1898 = ATCC 22649, from human brain abscess, J. Bennett, FL; NCMH 474 = NCMH 767 = CDC B-2525, from brain abscess in a cat, Biberstein, Davis, CA; NCMH 767 = NCMH 474 = CDC B-2525, from brain abscess in a cat, S. Jang *et al.*, Davis, CA; NCMH 1145 = DMD-38, from sawdust mulch heap, D. Dixon, Williamsburg, VA; NCMH 1146 = DMD-41, from sawdust mulch heap, D. Dixon, Williamsburg, VA; NCMH 1147 = DMD-58, from stump of *Juniperus virginiana*, D. Dixon, Suffolk, VA; NCMH 1148 = DMD-39, from sawdust mulch heap, D. Dixon, Williams-

Table 1. Measurements of *Cladosporium bantianum* conidia in herbarium specimens

Specimen	Average size (μm)	Range (μm)
Exsiccatum labelled 499	4.6 X 8.4	3.1-7.3 X 5.6-13.0
DMD-38	3.1 X 6.9	2.2-3.9 X 5.7-9.2
DMD-39	3.4 X 7.5	2.7-4.1 X 5.1-14.0

Table 2. Measurements of *Cladosporium bantianum* conidia after 2 weeks on potato dextrose agar at 25°C

Isolate	Average size (μm)	Range (μm)
NCMH 111	2.5 X 6.4	1.8-3.2 X 4.5-10.0
NCMH 112	2.7 X 7.2	2.1-3.6 X 4.8-10.5
NCMH 113	3.0 X 6.3	2.3-4.0 X 4.7-11.0
NCMH 114	2.7 X 6.2	2.0-3.4 X 5.0-9.2
NCMH 115	2.8 X 7.2	2.0-3.8 X 5.0-13.8
NCMH 116	2.9 X 5.7	2.3-3.5 X 4.6-8.3
NCMH 117	2.7 X 6.4	2.0-3.5 X 4.6-10.6
NCMH 121	3.0 X 5.9	2.1-6.5 X 4.0-8.5
NCMH 122	2.7 X 5.5	2.1-3.3 X 4.0-8.0
NCMH 474	2.7 X 5.3	2.1-3.1 X 3.8-8.5
NCMH 767	3.1 X 6.5	2.1-4.0 X 4.1-12.0
NCMH 1145	2.9 X 5.8	2.5-3.5 X 4.1-9.0
NCMH 1146	3.0 X 5.3	2.3-3.7 X 3.7-9.0
NCMH 1147	2.9 X 6.3	2.1-3.5 X 5.0-8.5
NCMH 1148	3.1 X 6.2	2.0-4.4 X 4.0-11.8
NCMH 1151	3.1 X 5.9	2.5-4.1 X 3.8-9.0
NCMH 1152	2.8 X 6.6	2.1-3.2 X 4.8-11.0
NCMH 1168	2.6 X 5.5	2.1-3.1 X 3.8-11.5
NCMH 1181	2.8 X 5.8	2.1-3.7 X 4.2-8.5
NCMH 1182	3.0 X 5.6	2.5-3.5 X 4.0-7.6
NCMH 1186	3.2 X 8.0	2.5-4.0 X 5.0-14.6

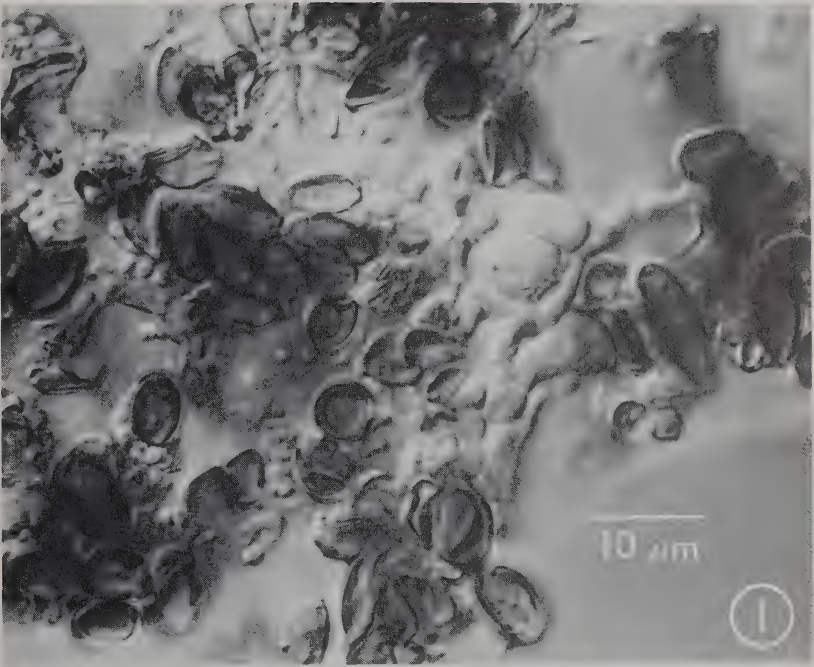
burg, VA; NCMH 1151 = ATCC 24928, from human brain abscess, P. F. Jurgensen; NCMH 1152 = ATCC 28255 = Crichlow 853, from human brain abscess, D. K. Crichlow; NCMH 1168 = CBS 328.65, from a dog, G. A. de Vries; NCMH 1181 = SM 1502, from human brain abscess, M. Hironaga, Otsu, Japan; NCMH 1182 = SM 1522, from human cutaneous abscess, M. Hironaga, Otsu, Japan; NCMH 1186 = FCM 7819, from human skin lesion, S. Amma, North Kerala, India.

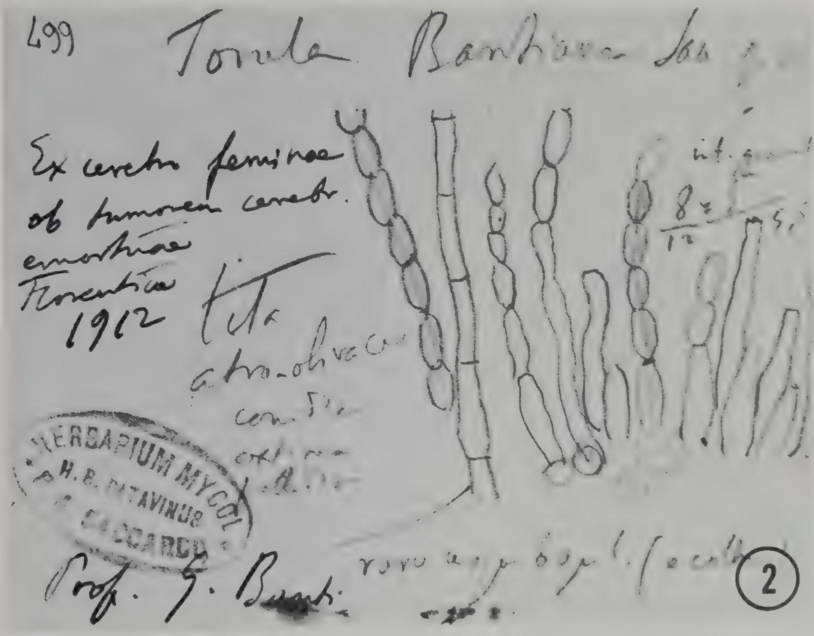
DISCUSSION

Measurements of the conidia preserved in the holotype (Fig. 1) for *C. bantianum* are 4.6 X 8.4 μm (3.1-7.3 X 5.6-13.0 μm) (Table 1), which vary a little from the measurements included in the original description (6) for the species, and those measurements recorded by Saccardo in his notes (Fig. 2). Saccardo described the conidia as ..."conidiis longe et sat persistenter catenulatis (in quaque catenula 5-10), concoloribus, oblongo-ellipsoideis, 8-11 X 5, levibus, intus granulosis, summis junioribus et pallidioribus." Even though Saccardo makes no statement concerning whether or not the chains were simple or branched, his photomicrograph of *C. bantianum* (Fig. 3) clearly shows that the chains were branched. Figure 3 also reveals that some of the chains consisted of more than ten conidia. The exsiccatum contains a few blastoconidia that have three hila, which confirms that the chains were branched.

Emmons *et al.* (5) have interpreted the original description of *C. bantianum* as follows: "Saccardo stated that *T. bantiana* produced conidia 8 to 11 X 5μ in unbranched chains which were only 5 to 10 cells in length". Their translation of the Latin diagnosis for *C. bantianum* is apparently in error since Saccardo considered only the conidiophores to be simple. He described them as ..."conidiophoris ex mycelio hypostromatico brevi, celluloso ascendentibus, fasciculatis, cylindraceis, simplicibus, subrectis, variae longitudinis, plerumque 15-30μ

Figs. 1-2. *Cladosporium bantianum.* 1. Lactophenol preparation of exsiccatum labelled 499, *Torula bantiana* Sac., Herbarium Mycol. Orto Botanico, Padova, Italy, P. A. Saccardo, in differential interference contrast microscopy. 2. Notes prepared by P. A. Saccardo for *Torula bantiana* Sacc.





499 Torula Bantiana Sacc.

Ex cerebro feminae
ob tumorem cerebr.
emortuae
Florentiae
1912

Fila
atro-olivacea
conidia

HERBARIUM MYCOL.
H. B. PATAVINUS
P. SACCARDO

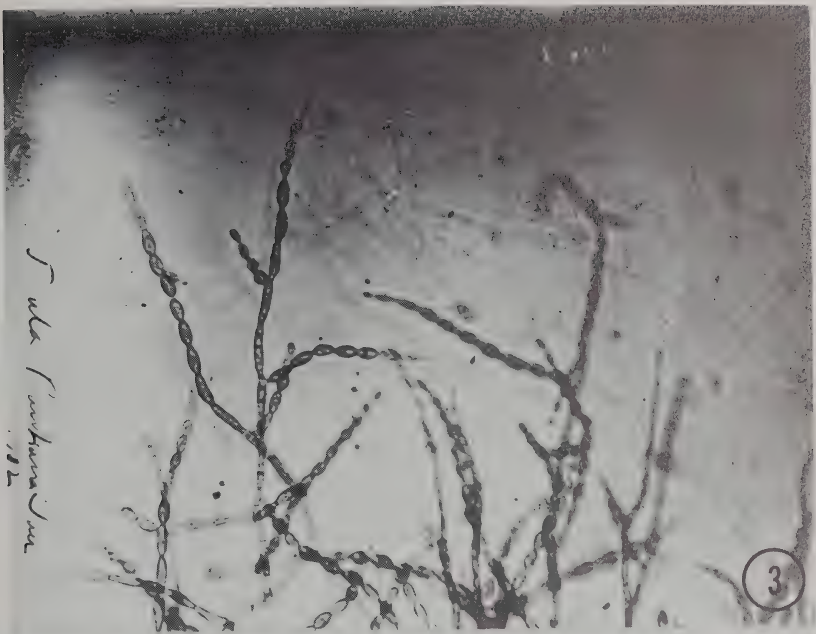
Prof. G. Banti

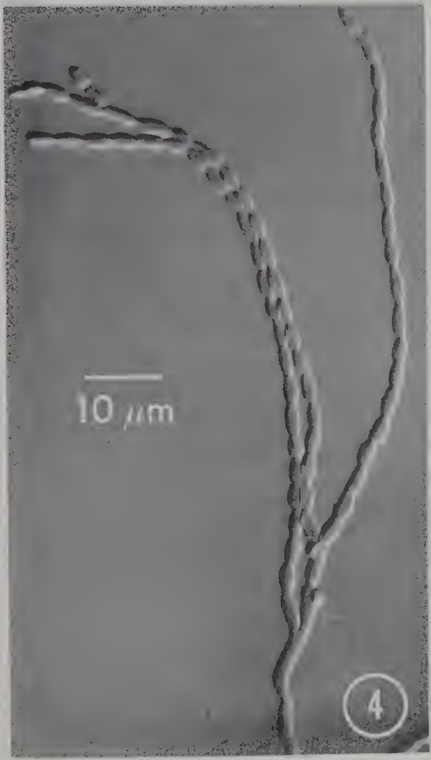
long, raro usque ad 60µ (ex cultura)..." Owing to their incorrect translation of the nature of the conidial chains for *C. bantianum*, they stated: "If the name, *T. bantiana*, is based on both Saccardo's descriptions and Borelli's interpretation of a photomicrograph attributed to Saccardo, then the name, *T. bantiana*, apparently is based on two fungi and is a *nomen confusum*." Figure 3 is the photomicrograph published by Borelli in 1960 (4) that is referred to by Emmons *et al.* It clearly shows that the chains were branched and that only one fungus was involved.

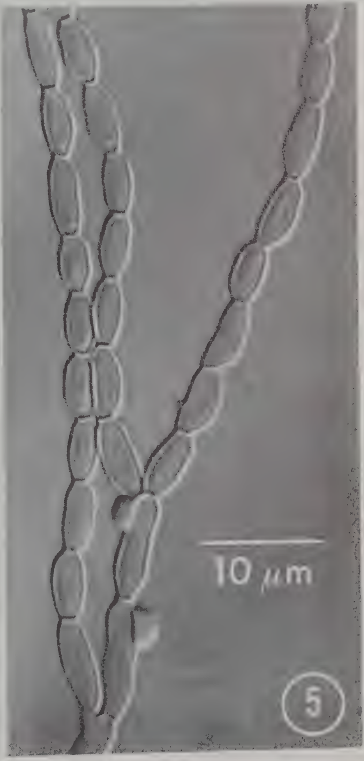
It has been argued that *C. bantianum* and *C. trichoides* should be maintained as separate species because of differences reported in the number of conidia composing the chains (5). Emmons in Binford *et al.* (3) described the conidia of *C. trichoides*, in part, as "Conidiis ellipsoidis vel cylindraceis, 2-2.5 X 4-10µ, continuis vel 1-septatis, fuscis, aequalibus, formatis in cateniis longis ramosisque." No mention was made by Emmons of the length of the conidial chains other than that they were long, but his figure 5 shows the longest chain to posses six conidia. Examination of NCMH 113 (Figs. 4-5), and additional cultures have revealed that the chains are much longer, often consisting of 35 or more conidia. Even though Saccardo stated that the conidial chains of *T. bantiana* consisted of 5-10 conidia, his photomicrograph (Fig. 3) shows that some of the chains were longer.

Emmons *et al.* (5) have observed that isolates of *C. bantianum* ..."have been remarkably uniform in morphology and size of spores, although a few strains have borne larger spores in primary cultures than those described by Emmons, reverting to spores of typical dimensions upon subculture." A comparison of DMD-38 and DMD-39 (Table 1) with NCMH 1145 and NCMH 1148, respectively (Table 2), supports the observation that the conidia tend to become smaller in size upon subculture. In a personal communication to Dr. Borelli, J. Bennett (National Institutes of Health, Bethesda, MD) studied a brain isolate that he

Figs. 3-5. *Cladosporium bantianum.* 3. Photomicrograph prepared by P. A. Saccardo of *Torula bantiana* showing its microscopic morphology. 4-5. Branched chains of blastoconidia (NCMH 113), potato dextrose agar after 2 weeks at 25°C, in differential interference contrast microscopy.


3


10 μm
4


10 μm
5

identified as *C. trichoides*. Bennett's isolate produced conidia that were approximately the same size as those described for *C. bantianum* by Saccardo. Unfortunately, Bennett's isolate could not be included in this study because it had died several years ago. After examining the living cultures listed in Table 2, it is obvious that the conidia of *C. bantianum* vary in size, ranging from 1.8-6.5 X 3.7-14.6µm. The size range seen in the exsiccatum is 3.1-7.3 X 5.6-13.0µm, which is compatible with the variation observed in the living isolates. This similarity in conidial size clearly supports the conclusion that *C. bantianum* and *C. trichoides* are conspecific, even though the conidia in the exsiccatum tend to be larger than those in the living cultures.

There is no doubt that Banti's isolate had the ability to grow at 37°C (6). In fact, Banti found that his fungus was pathogenic for rabbits (7), whose body temperature is approximately 40°C. Since there is no living culture of Banti's isolate, it is impossible to determine whether it could grow at 42-43°C. Borelli (4) demonstrated that isolates of *C. bantianum* can grow at this high temperature. The thermotolerance and neurotropism in man of the original isolates of *C. bantianum* and *C. trichoides* add additional support to the conspecificity of these two taxa.

Another controversial point is the reported color of the human brain lesions. According to Banti's description (1), the cerebral nodules were ..."of a deep brown color, giving one the impression of a melanotic sarcoma." According to Emmons *et al.* (5), the lesions caused by *C. trichoides* occur as gray abscesses. Judging by what is published in the literature, this aspect of the disease is variable. For example, in a Venezuelan case (2), the lesions were described as gray-blackish. In the necropsy protocol of Banti's case, which was reproduced by Stigliani (7), the lesions were described as a ..."dirty gray... from which a thick, mucous thread-like, grayish-greenish liquid came out...". The latter text was most likely dictated by Banti during the performance of the necropsy. Since the color of the lesions could have darkened within a few hours, this may have resulted in the different descriptions of the lesion color. The contention by Emmons *et al.* (5) that the pathological aspects of the two infections are significantly different enough to maintain *C. bantianum* and *C. trichoides* as separate taxa is unjustifiable.

It is apparent that *C. trichoides* and *C. bantianum* are conspecific. The arguments put forth by Emmons *et al.* for maintaining these as separate taxa are not compelling. *Cladosporium bantianum* can be characterized as growing at temperatures up to 42-43°C and by producing long, sparsely branched chains of blastoconidia consisting of as many as 35 or more conidia. The conidia are smooth, 1-celled (rarely 2-celled), oval to oblong-ellipsoidal, 3.0 X 6.4μm (1.8-7.3 X 3.7-14.6μm), and pale brown. The conidia arise from hyphae or simple septate conidiophores that are pale brown in color. The nomenclature is:

Cladosporium bantianum (Sacc.) Borelli, Riv. Anat. Patol. Oncol. 17:618, 1960.

≡ *Torula bantiana* Sacc., Ann. Mycol. 10:320, 1912. (basionym)

= *Cladosporium trichoides* Emmons in Am. J. Clin. Pathol. 22:540-541, 1952.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. Donald P. Rogers for reviewing our manuscript, Professor Sergio Chiesa for loan of the herbarium material maintained in the Saccardoan Herbarium, and Dr. Dennis Dixon for loan of his slide culture preparations and living cultures.

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4. Borelli, D. 1960. *Torula bantiana,* agente di un granuloma cerebrale. Riv. Anat. Patol. Oncol. 17:615-622.
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6. Saccardo, P. A. 1912. Notae mycologicae. I. Fungi ex Gallia, Abyssinia, Japonia, Mexico, Canada, Amer. bor. et centr. Ann. Mycol. 10:310-322.
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MYCOTAXON

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A PRELIMINARY DISCOMYCETE FLORA OF MACARONESIA: PART 2, HYALOSCYPHACEAE SUBF. ARACHNOPEZIZOIDEAE*

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> "Much like a subtle spider which doth sit
> In the middle of her web, which spreadeth wide."
> Sir John Davies
> THE IMMORTALITY OF THE SOUL

Order HELOTIALES
Suborder HYMENOSCYPHINEAE
Family HYALOSCYPHACEAE Nannf. 1932
Subfamily ARACHNOPEZIZOIDEAE Korf 1978
Tribe Arachnopezizeae Nannf. in Korf emend. Korf 1978

ONE KNOWN MACARONESIAN GENUS

ARACHNOPEZIZA Fuckel 1870 emend. Korf 1952

Key to the known Macaronesian species

1. Ascospores 5-7-septate at maturity. **3. A. aurata**
1'. Ascospores 0-1-3-septate at maturity 2

2(1'). Ascospores 0-1(-2)-septate at maturity; apothecia on husks of chestnut (Castanea) burrs 3
2'(1'). Ascospores mostly 3-septate at maturity; apothecia on wood, leaves, duff, acorns 4

3(2). Hairs thin-walled, tapering, usually 1-septate,

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* This flora will appear in an irregular order, with Part 1, containing the introductory material, one of the last to be published. Reprints of individual parts will not be available. References will appear in the final part. For a geographical definition of **Macaronesia** and other special features of this flora, see the note on page 144.

not constricted at the septum.
1. A. aranea f. aranea

3'(2). Hairs thicker-walled, multiseptate, constricted the septa. **2. A. aranea f. monilipila**

4(2'). Apothecia 1-3 mm diam., ascospores 10.2-13.2(-16.1) x 2.2-3.7 µm.
4. A. aurelia

4'(2'). Apothecia less than 0.5 mm diam. 5

5(4'). Apical cells of hairs without cyanophilic contents; ascospores (13.5-)18.3-22(-26) x 2.9-3.7 µm; paraphysis apices variously deformed.
5. A. obtusipila

5'(4'). Apical cells of hairs with cyanophilic contents; ascospores (14.6-)16.1-25.7 x 2.2-4.4 µm; paraphysis apices filiform, not deformed.
6. A. zonulata

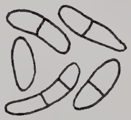
1. **Arachnopeziza aranea** (De Not.) Boud., Icones Mycol. Expl. Pl., sér. 3: 2. 1906 forma **aranea.**

≡ Lachnum aranea (De Not.) Lindau, in Engler & Prantl, Nat. Pflanzenfam. I **1** (130): 203. 1896.
≡ Arachnoscypha aranea (De Not.) Boud. ex Dennis, Mycol. Pap. **32**: 87. 1949.

RECENT TAXONOMIC TREATMENTS: Dennis (1949, 1978), Korf (1952).

PREVIOUS MACARONESIAN RECORDS: None.

TYPE LOCALITY: Italy.



A. aranea f. aranea, 5 ascospores, CUP-MM 1542, x 1000.

KNOWN MACARONESIAN DISTRIBUTION
MADEIRA.
Madeira. CUP-MM 1542.
CANARY ISLANDS.
La Palma. CUP-MM 870.

SUBSTRATA: On cupules (burrs) of Castanea sativa.

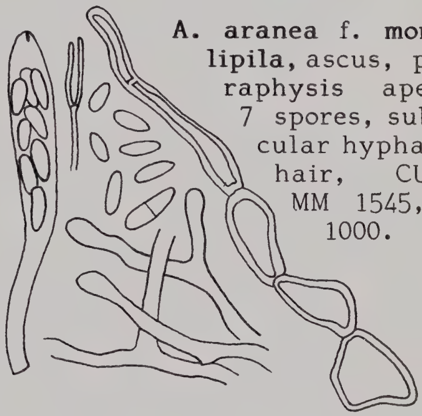
Notes: I saw one 2-septate ascospore in my mounts (illustrated), but typically the spores are either continuous or 1-septate. Probably common wherever chestnut grows, but difficult to find among the hairs on the inner surface of the spiny husks. I cannot agree with Dennis, who separated this species in a distinct genus, *Arachnoscypha* Boud., of which it is the type species, but which Boudier himself later abandoned. In my earlier monograph (Korf, 1952), I missed Lindau's transfer to *Lachnum*, which should be added to the synonymy given there.

2. **Arachnopeziza aranea** (De Not.) Boud. f. **MONILIPILA** Korf, **f. nov.**

PREVIOUS MACARONESIAN RECORDS: None.

A **Arachnopeziza aranea f. aranea** pilis multiseptatis miniliformibus differt.

Differing from the type form in having multiseptate rather than 1-septate hairs, and by the constrictions at the septa, giving the moniliform aspect to the hairs.



A. aranea f. **monilipila,** ascus, paraphysis apex, 7 spores, subicular hyphae, hair, CUP-MM 1545, x 1000.

HOLOTYPE: R.P. Korf, R. Fogel, G.L. Hennebert & L.M. Kohn, on cupules of *Castanea sativa*, *Castanea* grove below Pousada Vinháticos, Madeira, Portugal, 15.i.1977.

KNOWN MACARONESIAN DISTRIBUTION

MADERIA.

Madeira. CUP-MM 1545 (holotype).

SUBSTRATA: On spiny burrs of *Castanea sativa*.

Notes: The asci arise from repeating croziers, and the ectal excipular cells are quite large. The new form may represent merely a growth-stage of the species.

3. **Arachnopeziza aurata** Fuckel, Jahrb. Nassauischen Vereins Naturk. **23-24:** 304. 1870.

RECENT TAXONOMIC TREATMENTS: Dennis (1949, 1978), Korf (1952).

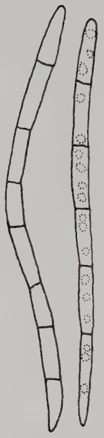
PREVIOUS MACARONESIAN RECORDS:
*Dennis & al. (1977).

TYPE LOCALITY: Germany.

KNOWN MACARONESIAN DISTRIBUTION

*AZORES.
***Terceira.** *Dennis & al., 7. iv.75 n.v.

CANARY ISLANDS.
Gomera. CUP-MM 1348, 1368(TFC).
Hierro. CUP-MM 1446(TFC), 1450.
La Palma. CUP-MM 898.
Tenerife. CUP-MM 223, 230, 246, 256, 298(TFC), 435(TFC), 508(TFC), 574, 1281.



A. aurata, 2 ascospores, CUP-MM 1145, x 1000.

SUBSTRATA: On wood and trunk of Erica arborea, on bark of Myrica faya, wood of Castanea sativa, and undetermined decorticated wood and bark.

Notes. This is surely the most common species of the genus in Macaronesia, as it tends also to be in North America and in Europe.

4. **Arachnopeziza aurelia** (Pers. : Fr.) Fuckel, Jahrb. Nassauischen Vereins Naturk. **23–24:** 303. 1870.

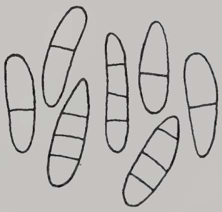
RECENT TAXONOMIC TREATMENTS: Dennis (1949, 1978), Korf (1952).

PREVIOUS MACARONESIAN RECORDS:
None.

TYPE LOCALITY: France.

KNOWN MACARONESIAN DISTRIBUTION

CANARY ISLANDS.
Hierro. CUP-MM 1459 (OSC, TFC).



A. aurelia, 7 ascospores, CUP-MM 1459, x 1000.

SUBSTRATA: On fruits and husks of Castanea sativa and other vegetable debris.

Notes: In North America and Europe this is most common on cupules and leaves of Quercus.

5. **Arachnopeziza obtusipila** Grelet, Amateur Champignons 8(3): 45. 1922, emend. Korf, Mycologia **43**: 213. 1951.

RECENT TAXONOMIC TREATMENTS: Korf (1951, 1952).

PREVIOUS MACARONESIAN RECORDS: *Baagøe & al. (1972) as "inoperculat discomycet."

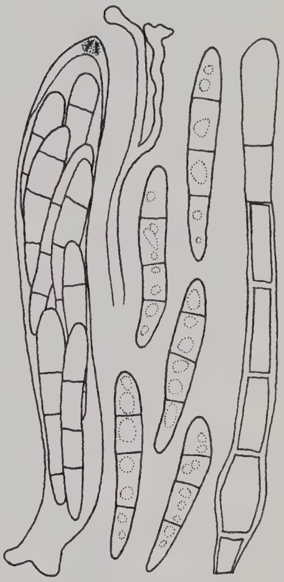
TYPE LOCALITY: France.

KNOWN MACARONESIAN DISTRIBUTION

*MADEIRA.
***Madeira.** *CUP-MM 2502(C).

SUBSTRATA: On decorticated wood of Pinus pinaster.

Notes: I am indebted to the students of the University of Copenhagen who collected this (Baagøe & al., 1972) and for calling the specimen to my attention for identification.



A. obtusipila, ascus, paraphysis, 5 ascospores, hair, CUP-MM 2502, x 1000.

6. **Arachnopeziza zonulata** (Rolland) Boud., Hist. classific. discomyc. Europe p. 126. 1907.

RECENT TAXONOMIC TREATMENTS: Korf (1952).

PREVIOUS MACARONESIAN RECORDS: None.

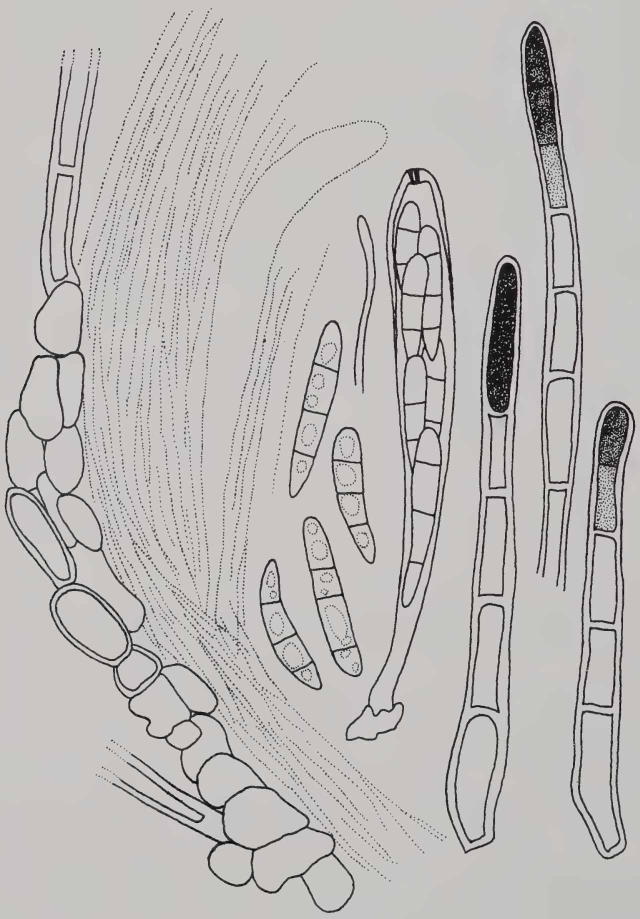
TYPE LOCALITY: Corsica (France).

KNOWN MACARONESIAN DISTRIBUTION

CANARY ISLANDS.
Tenerife. CUP-MM 1222.

SUBSTRATA: On wood of Pinus canariensis.

Notes: In the absence of type material, I (Korf, 1952) treated this as a doubtful species. If I am correct in interpreting this as Rolland's species, it is only critically distinct from A. obtusipila. Malençon and Bertault (1958) proposed varietal status for Grelet's species under A. zonulata, but their combination was not validly published. I have made 3 trips to Rolland's type locality near Corte, in Corsica, but did not find any species matching his description.



A. zonulata, section through the apothecial margin with 2 hair bases, 4 ascospores, paraphysis apex, ascus with J+ pore, 3 hairs in cotton-blue, CUP-MM 1222, x 1000.

Tribe Polydesmieae Korf 1978

ONE KNOWN MACARONESIAN GENUS

POLYDESMIA Boudier, Bull. Soc. Mycol. France 1: 113. 1885.

Key to the known Macaronesian species

1. Ascospores 1-3-septate at maturity, 9.0-13.5 x 2.2-2.7 µm. **1. P. fructicola**
1'. Ascospores 3-septate at maturity, (13.9-)14.6-20.5 (-22.0) x 3.7-5.1 µm. **2. P. pruinosa**

1. **Polydesmia fructicola** Korf, Mycotaxon 7: 475. 1978.

RECENT TAXONOMIC TREATMENTS: Korf (1978).

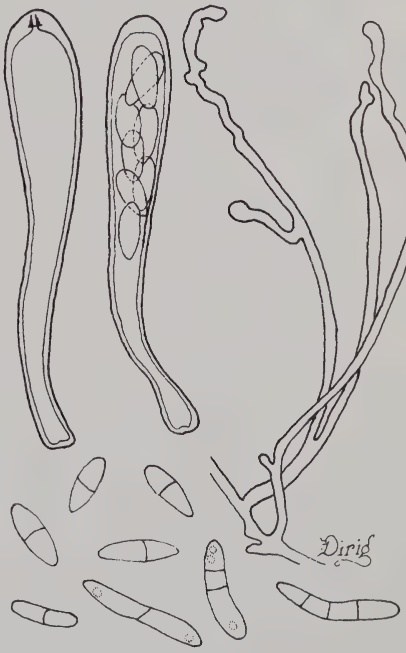
PREVIOUS MACARONESIAN RECORDS: *Korf (1978), †Beltrán Tejera (1980).

TYPE LOCALITY: Madeira.

KNOWN MACARONESIAN DISTRIBUTION

*MADEIRA.
***Madeira.** *CUP-MM 1504 (holotype) (TFC), *1533, *1551, *1556, *1618, *1619, *2333, *2361, *2362, 2366, *2391.
*CANARY ISLANDS.
***Tenerife.** *CUP-MM 1306.

SUBSTRATA: On peduncles, pods, twigs and wood of *Acacia* spp., bark and capsules of *Eucalyptus* spp., undetermined bark and branchlet.



P. fructicola, ascus with J+ pore, ascus with spores, paraphyses, 4 upper ascospores, CUP-MM 1504; 4 lower spores CUP-MM 2361; all x 1000.

2. **Polydesmia pruinosa** (Jerd. in Berk. & Br.) Boudier, Bull. Soc. Mycol. France **1**: 113. 1885.

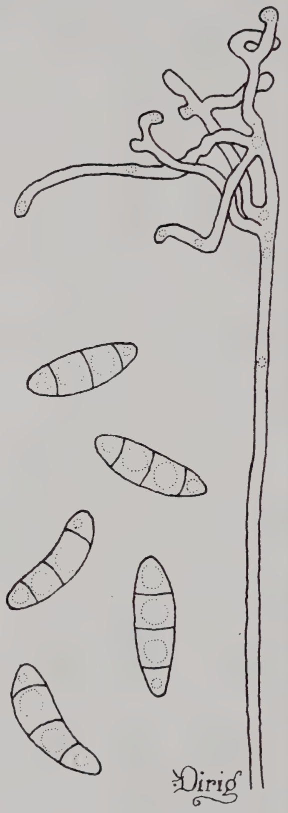
RECENT TAXONOMIC TREATMENTS: Dennis (1978), Korf (1978).

PREVIOUS MACARONESIAN RECORDS: *Korf (1978), †Beltran Tejera (1980).

KNOWN MACARONESIAN DISTRIBUTION

*MADEIRA.
  ***Madeira.** *CUP-MM 1481(TFC), *1627, *2277, *2345, 2406.
*CANARY ISLANDS.
  ***La Palma.** *CUP-MM 639 (TFC), *709.

SUBSTRATA: On pyrenomycetes, on pyrenomycetes immersed in wood, on branch of Acacia sp.



P. pruinosa, 4 ascospores, paraphysis apex, CUP-MM 1481, x 1000.

SPECIAL FEATURES OF THIS FLORA

Since Part 1, the introductory material, is to appear later, one reviewer of this part confessed he did not know where Macaronesia is, and that he could not find it in any of the atlases he consulted! Thus:

Macaronesia: the Atlantic island chain comprising the archipelagos of the Azores, Madeira, Salvage Islands, Canary Islands, and Cape Verde Islands. Etymology: from Greek, μάκαρος (fortunate) + νῆσος (island): "Les Îles Fortunes," "The Fortunate Islands." (Want to guess how often these papers will be cited as **Macron**esia instead of **Macaro**nesia?)

Substrates follow O. Eriksson, A. Hansen & P. Sunding. 1974. Flora of Macaronesia. Check-list of vascular plants, 1974. University of Umeå, Sweden. iv. + 66 pp.

Distributional symbols: Papers with previous Macaronesian records citing specimen data are indicated by one or more asterisks (* ** ***) and the corresponding specimens examined have been coded to those asterisks with their CUP-MM numbers; where such specimens cannot be located or were not available on loan, the symbol "n.v." follows brief specimen data. Papers citing taxa without giving specimen data, or merely repeating previous records, are indicated by a dagger or daggers († †† †††).

Herbarium abbreviations are those of the Index Herbariorum, ed. 6, and updates appearing periodically in the journal Taxon.

Without the generous financial assistance of the **National Science Foundation** (Grant DEB75-23557) this preliminary flora would never have been undertaken.

MYCOTAXON

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A PRELIMINARY DISCOMYCETE FLORA OF MACARONESIA: PART 3, HYALOSCYPHACEAE SUBF. TRICHOSCYPHELLOIDEAE*

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and

Plant Pathology Herbarium, Cornell University
Ithaca, New York 14853 USA

> "A Hair perhaps divides the False and True."
> Omar Khayyám [tr. Edward Fitzgerald]
> RUBÁIYÁT, Stanza 19

Order HELOTIALES
Suborder HYMENOSCYPHINEAE
Family HYALOSCYPHACEAE Nannf. 1932
Subfamily TRICHOSCYPHELLOIDEAE Nannf. 1932

ONE KNOWN MACARONESIAN GENUS

LACHNELLULA Karsten 1884 emend. Dennis 1962

Key to the known Macaronesian species

1. Apothecia white, with a bright orange hymenium, on living trees and cut ends of stumps of Pittosporum spp. 1. **L. pittospori** subsp. **azorica**

1'. Apothecia greenish-glaucus or grey to nearly black 2

2(1'). Apothecia grey to black. 2. **L. pulveracea**

2'(1'). Apothecia greenish-glaucus, strongly plicate. 3. **L. viridi-glauca**

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* The parts of this flora, under the editorship of Richard P. Korf, will appear in irregular order. Reprints of individual parts will not be available for distribution.

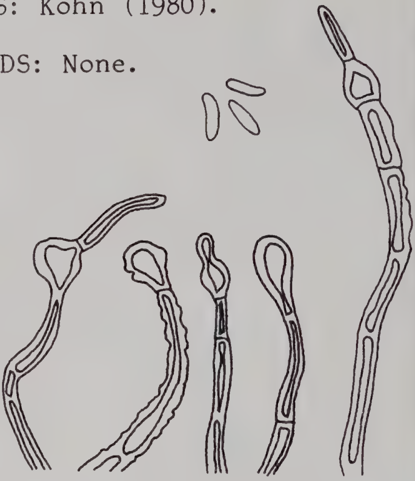
1. **Lachnellula pittospori** Kohn, Mycotaxon **12:** 278. 1980, subsp. **AZORICA** Kohn, **subsp. nov.**

RECENT TAXONOMIC TREATMENTS: Kohn (1980).

PREVIOUS MACARONESIAN RECORDS: None.

Cum subspecie typica **Lachnellulae pittospori** omnio conveniens sed pilos erectos apice tumidos (in subspecie typica non praesentes) ad marginem praebens. Hi pili ex cellula apicali saepe pariunt processum filiformem aliquando tumescentum et cellulam alteram supra eam primam formantem. Huius subspeciei novae distributio jam connita ad Insulas Azoricas limitata est. Holotypus: CUP-MM 2140.

Agreeing with the description of **L. pittospori** subsp. **pittospori** in all respects except for the presence of erect hairs with swollen apices at the margin, not present in subsp. **pittospori.** These hairs often produce from the apical cell a filiform process, which in some cases swells to form a second swollen cell above the first. The distribution of the new subspecies is so far as known limited to the Azores Islands. The type subspecies was described from Bermuda.



L. pittospori subsp. **azorica**, 5 marginal hairs, 3 ascospores, CUP-MM 2140, x 1000.

HOLOTYPE: R.P. Korf, L.M. Kohn, N. Korf & A.Y. Rossman, on stump of Pittosporum sp., Ribeira da Cruz, Lombas north of Caveira, Flores, Azores, Portugal, 13. iv.1978. (CUP-MM 2140.)

KNOWN MACARONESIAN DISTRIBUTION

AZORES.

Flores. CUP-MM 2138 (TFC), 2140 (holotype).
Terceira. CUP-MM 2009 (TFC).

SUBSTRATA: On Pittosporum spp., (stumps, cut areas of living trees, and rotted wood of standing trees).

2. **Lachnellula pulveracea** (Alb. & Schw. : Fr.) Dennis, Persoonia 2: 184. 1962.

RECENT TAXONOMIC TREATMENTS: Dennis (1949), Höhnel (1917).

PREVIOUS MACARONESIAN RECORDS: *Dennis & al. (1977).

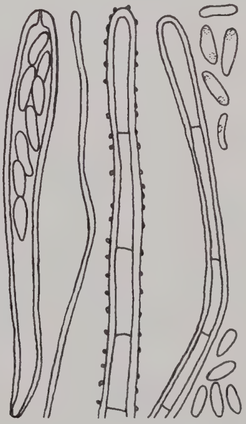
TYPE LOCALITY: Germany.

KNOWN MACARONESIAN DISTRIBUTION

*AZORES.
***Terceira.** *CUP-MM 1681(K), 2011, 2382, *Dennis & al. 3.iv.75 n.v.
MADEIRA.
Madeira. CUP-MM 1560, 1621, 1623.
CANARY ISLANDS.
Gomera. CUP-MM 1343, 1354(TFC).
Hierro. CUP-MM 1424, 1444(TFC), 1477.
La Palma. CUP-MM 825.
Tenerife. CUP-MM 87, 248, 538, 1212(TFC).

SUBSTRATA: On twig of *Acacia* sp., of *Ilex perado* subsp. *platyphylla*, of *Ulex europeus* and *Ulex* sp., on stem of *Rubus* sp., and on undetermined twigs, bark, wood, cut stumps, branches and roots.

Notes: This distinctive species, collected on various woody substrates, is characterized by apothecia that turn violet in KOH and reddish in iodine, as noted by Dennis (1949) and by Höhnel (1917: No. 1020). As Höhnel also noted, often the asci are immature. The apothecial structure is typically Trichoscyphelloideus, with a completely gelatinized long-celled ectal excipulum, unlike that in Hyaloscyphoideae. In lactic acid-

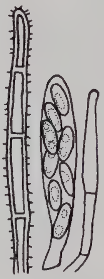


L. pulveracea, ascus, paraphysis, hair in KOH-phloxine-glycerine, hair in lactic-blue (CUP-MM 87); 5 upper spores (CUP-MM 1477); 5 lower spores (CUP-MM 1354); all x 1000.

cotton-blue the granulations on the hairs are no longer visible. Raitviir (1970) treated it as a doubtful or excluded species of the genus *Lachnellula*, and Dharne (1965) did not recognize it in the genus. Rehm's Ascomyceten No. 1580, issued as *Dasyscypha coerulescens* var. *dealbata* Rehm, was examined and found to be conspecific, confirming Dennis's (1949) synonymy.

3. **Lachnellula VIRIDI-GLAUCA** Kohn, **sp. nov.**

PREVIOUS MACARONESIAN RECORDS: None.



L. viridi-glauca, hair, ascus and paraphysis, CUP-MM 850, x 1000.

Apothecia gregaria vel fasciculata, viridi-glauca, sessilia, pilis albis vestita, profunde cupulata, receptaculi parietibus penitus plicatis praesertim in apotheciis immaturis; receptaculum 0.25-0.50 mm in diam.; commutatio xanthochroica in 2% KOH eveniens. Excipulum medullare ex textura intricata hyalina formatum, cellulis 2-3 µm latis. Excipulum ectale ex textura oblita formantum hyalina intertexta in gelatina copiosa flava contenta, cellulis 3-6 µm latis, exterioribus pilos edentibus. Pili hyalini, erecti, septati, grosse granulosi, 35-45 x 2 µm. Asci clavati, 36-45 x 5-6 µm , ex uncis iteratis enati, 8-spori, apice magnopere incrassato, pori canalis pariete J- cum/sine usu KOH antecedente. Ascospori ellipsoidei vel interdum allantoidei, 2-multi-guttulati, 6-7 x 2-2.5 µm. Paraphyses filiformes, septatae, ramosae, ascos longitudine aequantes, 1 µm latae, in gelatina contente. Holotypus: CUP-MM 850.

Apothecia gregarious to fasciculate, greenish-glaucus, sessile, clothed in white hairs, deeply cupulate, walls of receptacle deeply plicate, especially in young apothecia; receptacle 0.25-0.5 mm diam; xanthochroic reaction in 2% KOH. Medullary excipulum of hyaline textura intricata, cells 2-3 µm wide. Ectal excipulum of hyaline, interwoven textura oblita bound in a copious, yellowish gel, cells 3-6 µm wide, outer cells giving rise to hairs. Hairs hyaline, erect, septate, coarsely granulate, 35-45 x 2 µm. Asci clavate, arising from repeating croziers, 8-spored, apex greatly thickened, pore channel wall J- with or without KOH pretreatment, 36-45 x 5-6 µm. Ascospores ellipsoid or occasionally allantoid, 2-

multiguttulate, 6-7 x 2.0-2.5 µm. Paraphyses filiform, septate, branched, same length as asci, 1 µm wide, bound in gel.

HOLOTYPE: R.P. Korf, W.C. Denison, L.M. Kohn & M.A. Sherwood, on wood of ?Castanea sativa Mill., near mine entrance at Km mark 13, road between Buenavista and El Paso, La Palma, Canary Islands, Spain, 18.i.1976. (CUP-MM 850.)

KNOWN MACARONESIAN DISTRIBUTION

CANARY ISLANDS.
La Palma. CUP-MM 850 [holotype] (TFC, isotype).

SUBSTRATA: On wood (of ?Castanea sativa).

Notes: The greenish-glaucus color, the deeply plicate receptacle (giving young apothecia the appearance of a "bundt cake"), and the xanthochroic reaction in 2% KOH makes this species especially distinctive. Nevertheless, the ectal excipulum composed of textura oblita and the granulate hairs show Trichoscyphelloideus affinities. Note that young apothecia often have no asci and bear a copious gel layer above the hymenium.

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RESINOMYCENA GEN. NOV. (AGARICALES), AN ALLY OF HYDROPUS, MYCENA AND BAEOSPORA

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ABSTRACT

A new genus, *Resinomycena*, is proposed to accommodate *Agaricus rhododendri*, the type, *Mycena kalalochensis*, and three new species, *R. brunnescens*, *R. montana* and *R. acadiensis*. At present the genus is known with certainty only from North America. The relationships to the genera *Baeospora*, *Hydropus* and *Mycena* are discussed.

Agaricus rhododendri Peck and *Mycena kalalochensis* A.H. Smith along with three previously undescribed taxa form a clearly defined taxon characterized by amyloid spores, pseudoamyloid tramal tissues and a turf-like pileal epicutis composed mainly of resin secreting oleocystidia.

In her monograph of the northeastern *Marasmius* species, Gilliam (1976), excluded *M. resinosus* Peck (= *A. rhododendri*) and suggested that a new genus might need to be proposed for it. A.H. Smith (1947) excluded both *Omphalia rhododendri* (Peck) Sacc. and *M. resinosus* from *Mycena* although at the same time describing *M. kalalochensis* as a new species of *Mycena*. These epithets were not dealt with in *The Agaricales in Modern Taxonomy*, (Singer 1975). In this last publication the species described here clearly key out to the *Tricholomataceae tribus Myceneae* and less clearly to the choice between *Hydropus* and *Mycena*. However, the delimitations of both genera exclude the group. Thus the recognition of a distinct genus is a viable option. Alternatively emendation of *Hydropus* or *Mycena* from the concepts accepted in *The Agaricales in Modern Taxonomy* could be proposed. The emendation of *Baeospora* by the inclusion of *Baeospora pallida* Singer (1977), a species with close but not crowded lamellae and white carpophores, is cause for considering this last genus as a possible depository for *A. rhododendri* and allies. As detailed at the end of this paper, the erection of a new genus most clearly resolves the problems surrounding the placement of these species. Emendation of existing genera would make them too heterogeneous.

Resinomycena Redhead & Singer, *gen. nov.*

Habitus omphaliodeus vel marasmioideus, superficeibus ± resinosis ex oleocystidiis (frequenter intermixtis elementis filamentosis vel dendroideis). Lamellis adnati vel subdecurrentibus, confertis vel subdistantibus (haud confertissimis), ad aciem oleocystidiis numerosis instructis. Stipe aequalis, subcartilagineo, sicco subcorneo, ± resinaceo. Tramate debiliter vel sat manifeste pseudoamyloideo (partibus subgelatinascentibus exceptis); tramate hymenophorali regulari. Sporis hyalinis, amyloideis, levibus, acyanophilis.

Typus: Agaricus rhododendri Peck.

Basidiomes omphaloid or marasmioid, resinous, covered with oleocystidia intermixed with dendroid hyphae, white or dully pigmented. Lamellae adnate to slightly decurrent, close to subdistant but not crowded, with resinous edges formed by numerous oleocystidia. Stipe equal, cartilaginous but drying to a horny consistency, resinous, covered by scattered or clumped oleocystidia. Tramal tissues weakly to strongly pseudoamyloid where walls not slightly gelatinized, but frequently some inamyloid hyphae intermixed. Hymenophoral (lamellar) trama regular. Spores smooth, amyloid, hyaline, acyanophilic.

Type species: *Agaricus rhododendri* Peck.

A key to *Resinomycena* species

A. From Europe .... *Marasmius rhododendri* (see discussion)

A. From eastern North America .... B

A. From western North America .... D

B. Pileus brown; hyphae incrusted with brown pigments .... *R. brunnescens*

B. Pileus white or whitish; hyphae lacking pigmented incrustation C

C. Lamellae close; spores small, 5.4-8.5 X 2.4-4.1(-4.5)µm .... *R. rhododendri*

C. Lamellae moderately spaced to subdistant; spores large, 9.4-12.8 X 4-5µm .... *R. acadiensis*

D. Pileocystidia mainly capitate, secondarily septate, mostly erect; on angiosperm litter .... *R. kalalochensis*

D. Pileocystidia clavate but rarely capitate, rarely if at all secondarily septate and often collapsed to a repent condition; on coniferous litter .... *R. montana*

Resinomycena rhododendri (Peck) Redhead & Singer, *comb. nov.* Figs. 1-5.

≡ *Agaricus rhododendri* Peck (1875: 94)
≡ *Omphalia rhododendri* (Peck) Saccardo (1887: 335)
≡ *Omphalopsis rhododendri* (Peck) Murrill (1916: 311)
= *Marasmius decurrens* Peck (1872: 77) *nom. illeg. non. M. decurrens* Montag. (1854: 118)
≡ *Marasmius resinosus* Peck (1883: 181) *nom. nov.* for *M. decurrens* Pk.
= *Marasmius resinosus* var. *niveus* Peck (1903: 38)
≡ *Marasmius resinosus* var. *candidissimus* Peck (1905: 40) *nom. nov. illeg.* for *M. resinosus* var. *niveus* Pk.

PILEUS: 4-15(-19) mm wide, convex becoming plano-convex to plane, usually depressed centrally, occasionally umbilicate, rarely subumbonate, white to yellow white, opaque to vaguely striate marginally becoming obscurely corrugated-striate on some and sometimes obscurely concentrically ridged, dry to tacky or slightly viscid, micaceous when dry; edges incurved at first, uneven with age; context tough-pliant, concolourous; odor and taste not distinctive. LAMELLAE: adnate to subdecurrent or arcuate-decurrent, whitish, moderately narrow, close, often becoming forked in places or developing ladder-like anastomoses; edges crenulate, in some specimens beaded with resin. STIPE: 12-50 mm long, 0.5-1 mm wide, equal or slightly enlarged above, tough and pliant, drying to a corneus texture, whitish, varying from glutinous to tacky or dry and glistening from resinous cells in scattered beads, fistulose, with a silky radiating white basal disc or subiculum.

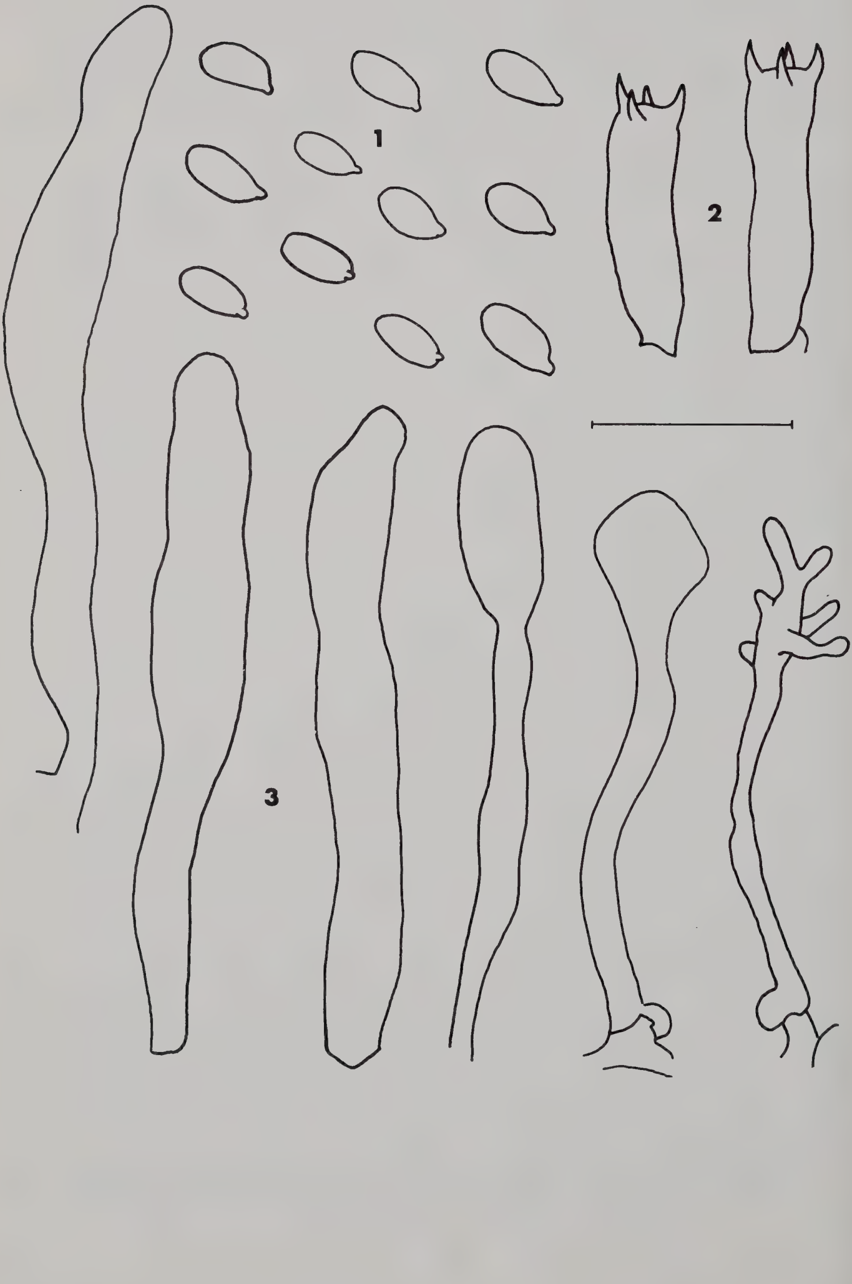
PILEAL EPICUTIS: a layer of polymorphic, suberect, later decumbent and tangled cystidia ranging from cylindrical narrowly clavate or capitate oleocystidia to narrow dendroid nonresinous forms with some intergradation, 40-60 X 3-9.5µm, hyaline, thin-walled, often filled or partially filled with vacuolate to homogeneous oily contents and covered with similar exudates which dry as slightly yellowish and hardened masses. PILEAL TRAMA: obscurely duplex, with slightly broader hyphae above, 5-15µm diam., than below, 3-10µm diam.; hyphae subparallel, clamped, smooth, walls thin to slightly thickened, faintly pseudoamyloid. LAMELLAR TRAMA: similar to pileal trama, varying to slightly interwoven, more definitely pseudoamyloid. CHEILOCYSTIDIA: abundant, forming a sterile edge, similar to the cylindrical to narrowly clavate or fusoid oleopileocystidia, 55-65 X 7-7.5µm. PLEUROCYSTIDIA: rare or absent, similar to the cheilocystidia. BASIDIA: 19-22 X 5-5.2µm, narrowly cylindrical to obscurely utriform, 4-spored, clamped. BASIDIOSPORES: 5.4-8.5 X 2.4-4.1(-4.5)µm often being predominantly at one or the other end of the range, mostly ellipsoidal or broadly cylindrical, inequilateral in profile, prominently apiculate, smooth, hyaline, thin-walled, amyloid.

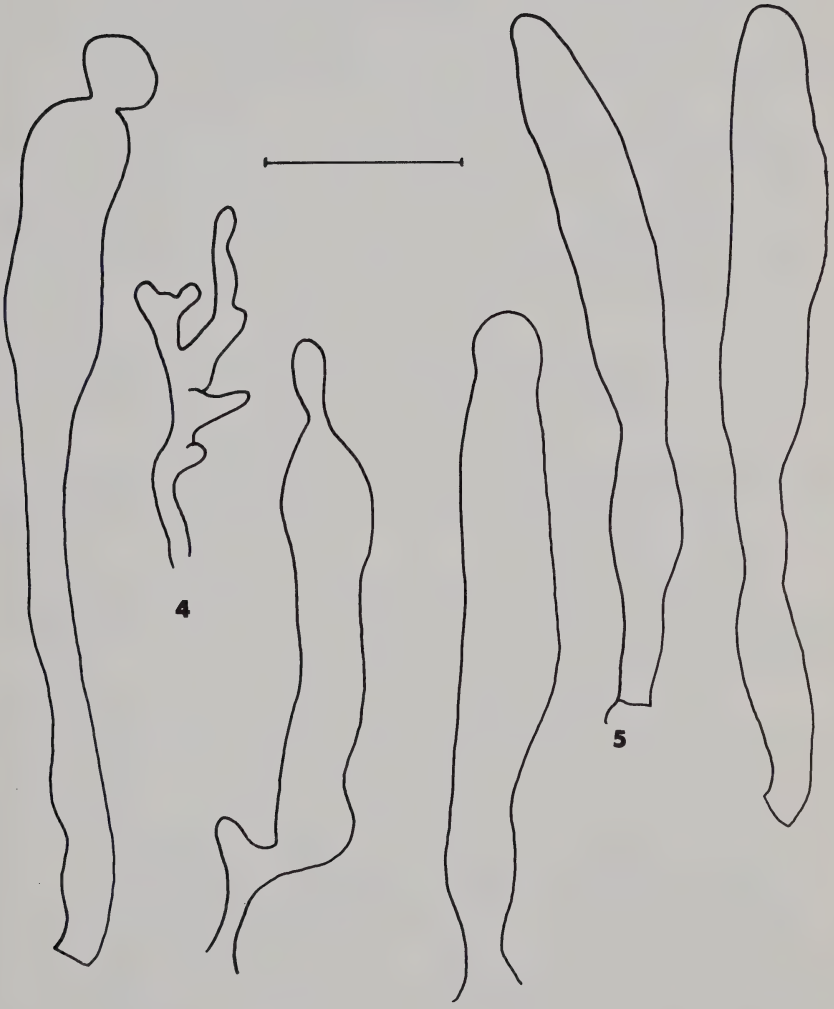
STIPE HYPHAE: parallel, 3-5µm diam. in the cortex, up to 10µm diam. in the medulla, mostly prominently pseudoamyloid in the medulla, walls uneven and slightly thickened. CAULOCYSTIDIA: similar to the pileocystidia, often clustered. BASAL MYCELIUM: interwoven, 2-3µm diam., smooth, inamyloid, clamped, hyaline, walls refractive and slightly thickened.

HABITAT, HABIT and SUBSTRATES: scattered to subcespitose on leaf litter, small twigs or bits of wood and woody fruits or husks from *Rhododendron*, *Quercus*, *Fagus*, *Castanea*, *Carya* and sometimes *Pinus* when mixed with *Quercus* in eastern hardwood forests.

COLLECTIONS EXAMINED: (only collectors initials cited after first full citation): CANADA: *Ontario:* London, Sept. 27, 1896, Aug. 18, 1897, Sept. 8, 1915, J. Dearness (DAOM); and probably London area, Sept. 11, 1903 and October 23, 1926, J.D. (DAOM); Toronto, July 12, 1932, H.S. Jackson (DAOM 50112, ex TRTC 3381). U.S.A.: *Georgia:* Rabun Co., Rabun Bald, Sept. 3, 1947, Walters 153 (MICH). *Illinois:* River Forest, bank of Desplaines R., July 1, 1902, E.T. & S.A. Harper 542 (F). *Kentucky:* Harlan, Sept. 4, 1916, C.H. Kauffman (MICH). *Michigan:* Lenawee Co., Cleveland L., Omsted State game area, Sept. 9, 1970, W. Patrick (M. Gilliam 939; MICH); Livingston Co., George Reserve, July 27, 1970, J. Williams (M.G. 834; MICH), Pinckney, Aug. 7, 1937, A.H. Smith 6823 (MICH). Oakland Co., Proud L., Oct. 10, 1970, M.G. 992 (MICH), Haven Hill, Aug. 8, 1972, A.H.S. 81375 (MICH); Washtenaw Co., Ann Arbor, July 25, 1912, C.H.K., Oct. 7, 1931, A.H.S., Aug. 3, 1935, A.H.S. 1699, Aug. 22, 1937, A.H.S. 7175, Aug. 11, 1960, A.H.S. 62873, July 11, 1970, C. Nimke (M.G. 693, 701), July 30, 1970, C. Nimke 49 (MICH), Gorman L., Aug. 20, 1972, A.H.S. 81620 (MICH), Halfmoon L., July 26, 1970, S.J. Mazzer 6186 (MICH), Manchester, July 4, 1935, A.H.S. 1470 (MICH), Sharon Hollow, Aug. 4, 1960, R.L. Shaffer 2513, Aug. 19, 1970, M. Gilliam 929, Sept. 16, 1970, M.G. 952 (MICH), Silver L. area, Aug. 22, 1960, R.L.S. 2646 (MICH), Waterloo Rec. area, Sept. 3, 1968, F. Hoseney 1094, July 10, 1970, F. Hoseney (M.G. 625), July 22, 1970, M.G. 786, July 2, 1971, F.H. 1800 (MICH), Winnewana, July 11, 1970, M. Gilliam 648 (MICH). *Minnesota:* Rice Co., Wheeling Twp., Nerstrand State Park, Aug. 29, 1965, M.G. Weaver 1243 (MICH). *North Carolina:* July 11, 1924, J.V. Couch 7380 (MICH), Swain Co., Flat Cr., Aug. 1, 1937, L.R. Hesler & A.J. Sharp (MICH). *New York:* Albany, rural cemetery, July-Aug. 1872, C.H. Peck [type of *M. decurrens*] (NYS); East Worchester, July, C.H.P. (NYS); Forestburgh, Sept. 1874, C.H.P. [type of *A. rhododendri*] (NYS); Genesee Co., Bergen Swamp, Sept. 4, 1972, H.S. Vishniac (MICH); Greenbush, Aug., C.H.P. (NYS); Ithaca, Aug. 11, 1904, C.H.K. (MICH), Aug. 1935, H.C. Beardslee Jr. 35074 (MICH); Port Jefferson, Aug. 6, C.H.P. [type of *M. resinosus* var. *niveus*] (NYS), Schuyler Co., Hector land rice area, Aug. 19, 1972, H.S.V. (MICH). *Ohio:* Lane, July 13, 1922, H.C.B. Jr. (MICH); Portage Co., West Branch State Park, July 8, 1972, M. Gilliam 1493 (MICH). *Pennsylvania:* Mt. Gretna, Sept. 5, 1926, C.H.K. (MICH); Media, June 29, 1940, P.M. Rea & Woodbury (MICH). *Tennessee:* Great Smoky Mts. Park, Cades Cove, Aug. 18, 1938, A.H.S. 10374, Indian Gap, Aug. 29, 1938, A.H.S. 10625, Aug. 7, 1942, L.R.H. 14476, Laurel falls trail, Aug. 8, 1938, A.H.S. 9909 (MICH).

Resinomycena rhododendri was first described by Peck (1872) as *Marasmius decurrens*. He apparently collected a similar fungus in





Figs. 1-5. *Resinomycena rhododendri* (DAOM, ex Dearness Oct. 23, 1926). 1, basidiospores. 2, basidia. 3, pileocystidia. 4, caulocystidia. 5, cheilocystidia.

Greenbush in 1869, #20, but lost the specimen before describing it (J. Haines, pers. comm.). Peck's validating description of *A. decurrens* indicated a dark taxon with a grayish or tawny pileus and a gray stipe. These colours are not apparent on the type of *A. decurrens*, microscopically or macroscopically, possibly indicating that more than one taxon was involved when the description was written. However, as the name is now lectotypified by Gilliam (*l.c.*), it applies to the pale form described in this paper. Peck (1883) not Saccardo (1887) as is often cited, later proposed the new name *M. resinosus* for *M. decurrens* which was a later homonym of *M. decurrens* Mont. However, Peck (1875) had in the meantime unknowingly described it a second time as *Agaricus rhododendri* which is, therefore, the earliest valid and legitimate name. His variety *niveus* is herein treated as being con-varietal with the type variety as it is now typified. The proposal of the new name *M. resinosus* var. *candidissimus* to replace *M. resinosus* var. *niveus* is superfluous under present nomenclatural rules, but it should be kept in mind that Peck was following the Rochester Code.

Smith (1947) was the first to recognize that *Agaricus rhododendri* and *Marasmius resinosus* were congeneric, although he reported the spores of *A. rhododendri* to be smaller, 3-4.5 X 2.5µm, than for *M. resinosus*. Bigelow (1970) treated the two as a conspecific but offered no evidence. In our studies spores measuring 6.5-7.2 X 3-3.2µm were found on the type of *A. rhododendri* which in other respects is typical for *M. resinosus*. Thus the two are treated as conspecific. Hesler's (1959) report of inamyloid spores for the type of *M. resinosus* is evidently in error as we concur with Gilliam (1976) that amyloid spores are present.

Resinomycena rhododendri appears to be restricted to the eastern deciduous forest where it occurs on litter of the dominating hardwood trees. It is the largest of the *Resinomycena* species and the one most commonly collected.

Resinomycena kalalochensis (Smith) Redhead & Singer, *comb. nov.*
Figs. 6-10.

≡ *Mycena kalalochensis* A.H. Smith (1947: 99)

> "Pileus 3-8 mm. broad, convex, remaining broadly convex, margin incurved at first, spreading in age, chalk white and appearing pruinose under a lens at first, glabrous and uneven in age but remaining chalky, slightly sulcate at maturity, not hygrophanous; flesh membranous and pliant (but not reviving), odor not distinctive, taste not recorded; lamellae adnate, broad, distant, 10-12 reach the stipe, two tiers of lamellulae, white over all, edges pruinose; stipe 3-7 mm. long less than 0.5 mm. thick, equal or the base flanged slightly, strigose, the remainder pruinose like the pileus, chalky white over all."
> Smith (1947: 99-100).

PILEAL EPICUTIS: an erect to suberect tangled turf of polymorphic cystidia, 25-50 X 3-8µm, varying from cylindrical to narrowly clavate, usually capitate to subcapitate, often secondarily septate, scantily resinous oleocystidia to variously branched to narrow dendroid and antler-like forms, which lack resinous exudates or contents, walls thin, hyaline, smooth, clamped basally. PILEAL TRAMA: somewhat duplex with slightly broader hyphae above, 5-15µm diam., than below, 5-10µ diam.; hyphae faintly pseudoamyloid initially but becoming more intense after several days in permanent Hoyer's-Melzer's reagent, clamped, smooth, thin-walled, subparallel. LAMELLAR TRAMA: hyphae similar to the pileus trama hyphae. CHEILOCYSTIDIA: abundant, forming a sterile edge, less variable than the pileocystidia, mostly narrowly cylindrical to slightly clavate, occasionally forked or branched, occasionally with an apical finger-like elongation, 31-48 X 5-6.5µm, scantily resinous. BASIDIA: 24-25 X 7.5-8.0µm, clavate to obscurely utriform, 4-spored, clamped. BASIDIOSPORES: 7.8-10.8 X 3.8-4.8µm, ellipsoid to obscurely fusoid or occasionally obovoid, inequilaterally flattened in profile, smooth, thin-walled, amyloid, hyaline, with a prominent apiculus. STIPE HYPHAE: parallel, 5-15µm diam., smooth, pseudoamyloid, hyaline, with the broadest hyphae in the medulla. CAULOCYSTIDIA: similar to the pileocystidia but only scantily resinous like the cheilocystidia. BASAL MYCELIUM: not studied.

HABITAT, HABIT and SUBSTRATES: Scattered on litter of *Rubus*, *Alnus rubra* Bong. and grasses in the coastal forest zone of western North America.

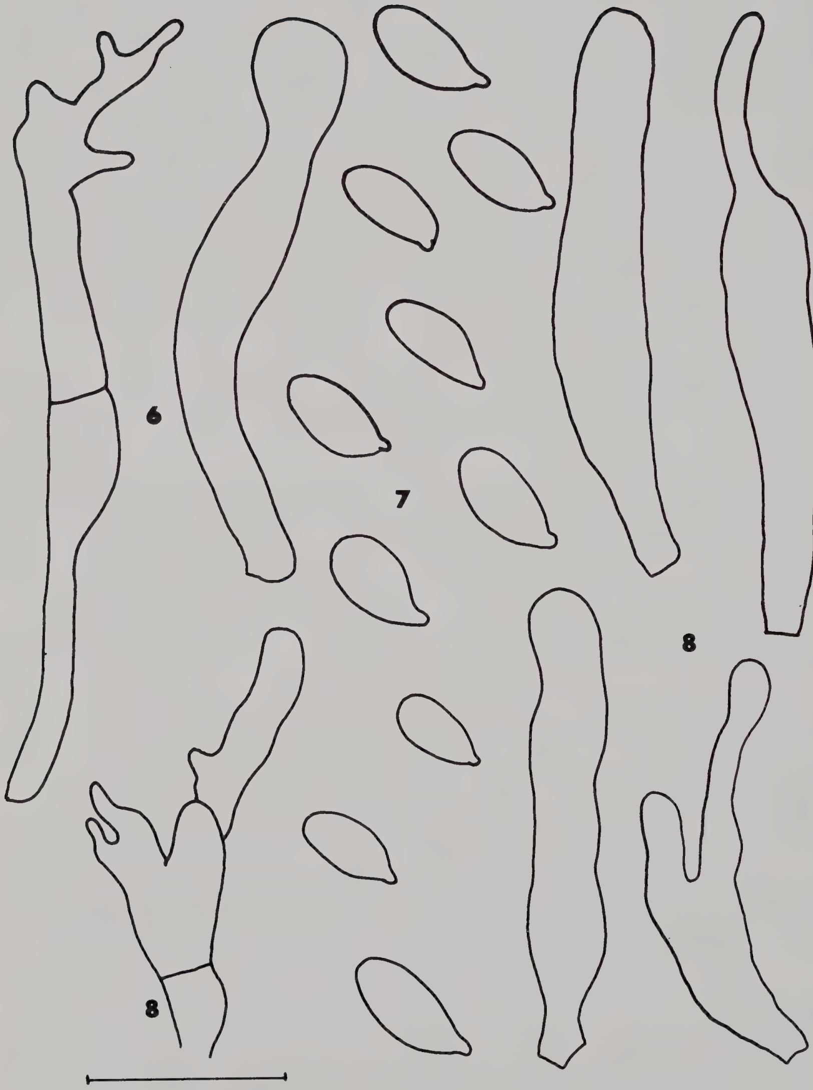
COLLECTIONS EXAMINED: CANADA: *British Columbia:* North Vancouver, Capilano Canyon, Oct. 8, 1973, S.A.R. #AS 9 (DAOM 166524), Vancouver, Univ. B.C., June 2, 1971, S.A.R. 342 (UBC). U.S.A.: *California:* Humbolt Co., Big Lagoon Park, Dec. 18 & 19, 1956, A.H.S. 56787, 56833, 56823, Prairie Cr. Park, Dec. 9, 1956, A.H.S. 56520 (MICH). *Oregon:* Seaside, Sept. 21, 1944, W. Gruber & A.H.S. 19020 (MICH). *Washington:* Jefferson Co., Kalaloch, April 30, 1939, A.H.S. 13035 [type] (MICH).

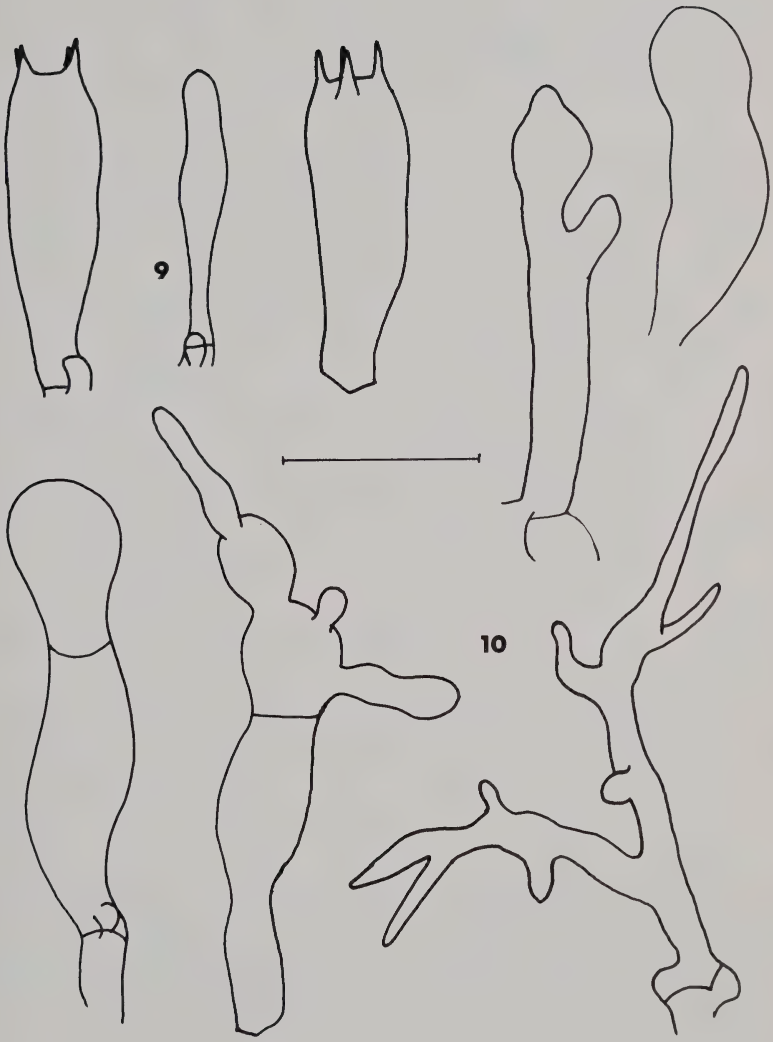
A.H. Smith (1947) reported slightly larger spores, 8-11 X 5-6µm, an inamyloid lamellar trama and a lack of incrustations on the pileocystidia. In our studies resinous exudates and dextrinoid tramal tissues were found on the type although the iodine reaction was not as prominent as that for the stipe. In addition, the resinous exudates tend to become clarified and dissolve in Melzer's reagent more so than in KOH 3% aqueous sol.

Resinomycena kalalochensis differs from *R. rhododendri* by distant lamellae, smaller basidiomes, larger spores, and more scant resinous exudates, in addition to the differences in geographic range and to a lesser extent substrates.

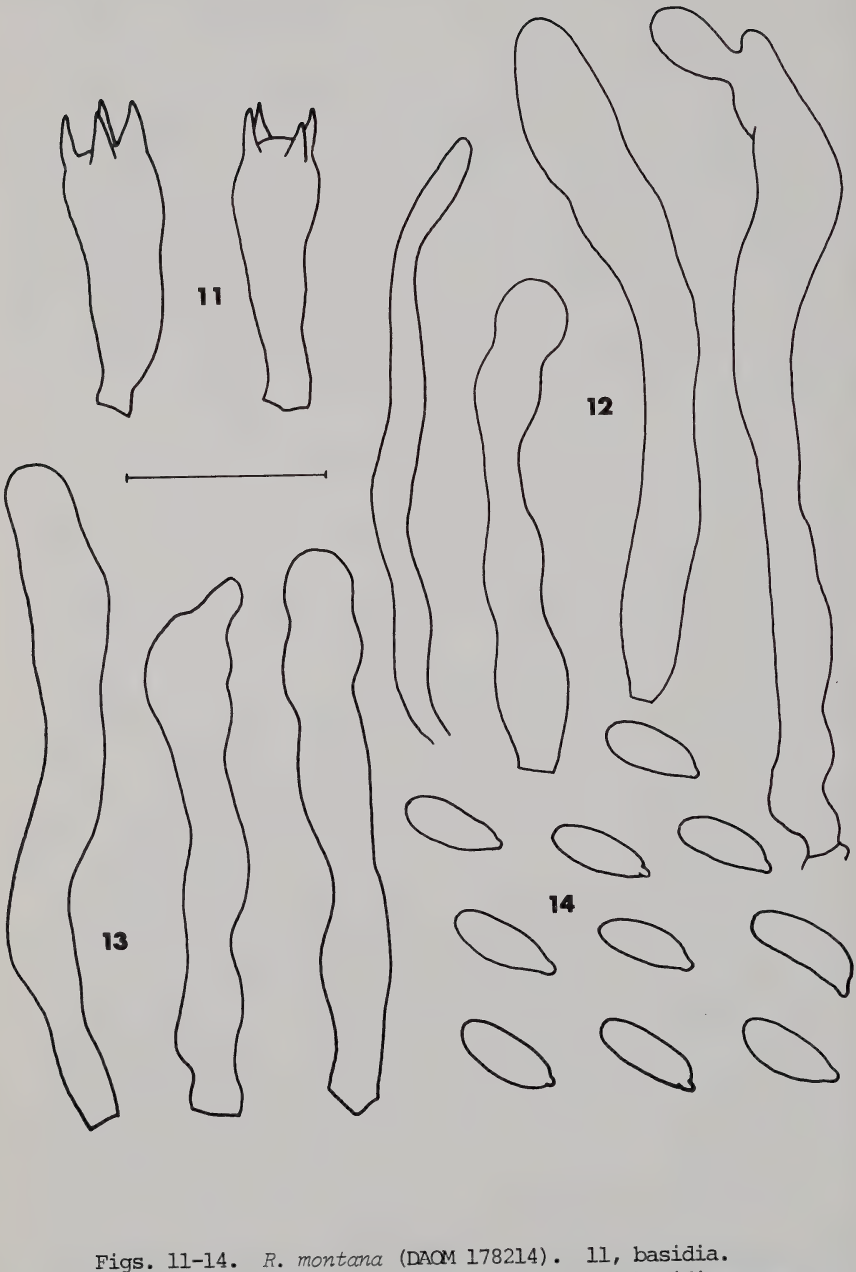
Resinomycena montana Redhead & Singer, *sp. nov.* Figs. 11-14,26.

Pileus 3.5-5.5 mm latus, convexus vel depressus, candidus. Lamellae arcuatae, candidae. Stipes 9-23 mm long., 0.4-0.6 mm crassus, candidus. Sporae 8-9.3 X 2.8-4.5µm, amyloideae, ellipsoideae. Pileocystidia 45-67 X 2.5-7µm, resinosa, clavata vel dendroidea ut nonresinosa. Cheilocystidia 42-52 X 6-6.2µm, resinosa, clavata vel strangulata. Tramate pseudoamyloideo.





Figs. 6-10. *R. kalalochensis* (DAOM 166524). 6, caulocystidia. 7, basidiospores. 8, cheilocystidia. 9, basidia. 10, pileocystidia.



Figs. 11-14. *R. montana* (DAOM 178214). 11, basidia. 12, pileocystidia. 13, cheilocystidia. 14, basidiospores.

Holotypus: DAOM 178215. Donald Station, Rocky Mt. trench, B.C., Canada, Sept. 21, 1980, S.A. Redhead 3977.

PILEUS: 3.5-5.5 mm wide, convex and slightly depressed centrally, vaguely striate to chalky white, micaceous, obscurely corrugated-striate, developing greyish casts when dry; context white, pliant; odor not distinctive. LAMELLAE: arcuate decurrent, moderately spaced, white, with micaceous edges; lamellulae in 2 tiers. STIPE: 9-23 mm long, 0.4-0.6 mm wide, equal, cargilaginous or tougher, white, finely powdered overall.

PILEAL EPICUTIS: a suberect to tangled turf of polymorphic cystidia 45-67 X 2.5-7µm, varying from a majority of elongated clavate oleocystidia to filiform or dendroid nonresinous elements. PILEAL TRAMA: obscurely duplex, with slightly broader hyphae above, 3-11µm diam., than below 3-5µm diam.; hyphae subparallel, faintly pseudoamyloid at first, smooth, clamped, thin to slightly thick-walled, hyaline. LAMELLAR TRAMA: hyphae similar to the lower pileal trama hyphae. CHEILOCYSTIDIA: abundant, forming a sterile edge, 42-52 X 6-6.2µm, narrowly clavate to cylindrical and slightly strangulate, occasionally with a short apical elongation, with scant to abundant resin exudates. BASIDIA: 20-21 X 6.8-7.2µm, clavate subcapitate, 4-spored, clamped. BASIDIOSPORES: 8-9.3 X 2.8-4.5µm, cylindrical to narrowly ellipsoidal, slightly inequilateral in profile, amyloid, smooth, hyaline, with a prominent apiculus. STIPE HYPHAE: parallel, pseudoamyloid especially on the slightly broader medulla hyphae, 4-13µm diam., smooth, thin to slightly thick-walled, clamped. CAULOCYSTIDIA: scattered to abundant and often clustered, similar to the pileocystidia. BASAL MYCELIUM: not studied.

HABITAT, HABIT and SUBSTRATES: scattered to gregarious on coniferous needles, cone debris and small twig fragments in western Subalpine, Coastal and Columbian coniferous forests of North America.

COLLECTIONS EXAMINED: CANADA: *British Columbia:* North Vancouver, Mt. Seymour, 3500' alt., Sept. 17, 1973, S.A.R. #AJ 3 (DAOM 178218); Sept. 22, 1973, S.A.R. #AI 24 (DAOM 178214); Columbia R. valley in Rocky Mt. trench at Donald Stn. on Hwy. 1 crossing of river, Sept. 21, 1980, S.A.R. 3977 [type] (DAOM 178215). U.S.A.: *Washington:* Lower Elwha, July 3, 1939, A.H.S. 14732 (MICH).

Resinomycena montana has longer spores than *R. rhododendri*, occurs on coniferous debris and usually develops a greyish cast on drying. Geographically the two are widely separated. *Resinomycena kalalochensis* differs by its more capitate and shorter pileocystidia which are often secondarily septate and scarcely resinous. Also the latter has smaller basidiomes which have not been observed to develop a grey cast and it occurs on angiosperm debris.

Resinomycena acadiensis Redhead & Singer *sp. nov.* Figs. 20-25.

Pileus 2-10 mm latus, convexus denum depressus, candidus. Lamellae arcuate, candidae. Stipes 10-40 (-70) mm long., 0.2-0.8 mm crassus, candidus. Sporae 9.4-12.8 X 4-5µm, amyloideae, ellipsoideae. Pileocystidia 30-58 X 3-9µm, resinosa, clavata vel nonresinosa ut *dendroidea. Cheilocystidia 38-40 X 6-8µm, aeque pileocystidia. Tramate pseudoamyloideo.*

Holotypus: DAOM 166073. Kouchibouguac Natl. Park, N.B., Canada Sept. 24, 1977, J.E. & S.A. Redhead 2558.

PILEUS: 2-10 mm wide, convex becoming depressed to cyathiform, translucent-striate but readily becoming opaque on partial drying, white to whitish, occasionally tinted fawn on the disc, rugose with age, moist to dry; edges incurved initially; context white, pliant; odor and taste not distinctive. LAMELLAE: arcuate-decurrent, becoming more distinctly decurrent, white, subdistant to moderately spaced; edges crenulate and often beaded; lamellulae in 2 tiers. STIPE: 10-40 (-70) mm long, 0.2-0.8 mm wide, equal or tapering up, white or with ochreous to rosy buff tints basally, glutinous when wet, powdered when dry, often attached to the substrate by a small radiating silky white mycelial pad.

PILEAL EPICUTIS: a suberect turf and later repent tangle of polymorphic cystidia 30-58 X 3-9µm, varying from short to long clavate oleocystidial forms to narrow filiform to dendroid nonoleocystidial forms with some intergradation, thin-walled, smooth, hyaline, with copious to moderate resinous exudates. PILEAL TRAMA: obscurely duplex with the broadest forms in the upper half, hyphae subparallel, 5-11µm, smooth, hyaline, faintly pseudoamyloid at first, clamped. LAMELLAR TRAMA: hyphae mostly parallel, 3-5µm diam., pseudoamyloid. CHEILOCYSTIDIA: abundant forming a sterile edge, similar to the pileocystidia but rarely of the branched forms, mostly clavate, 38-40 X 6-8µm. BASIDIA: 20-32 X 7-8µm, (2-)4-spored, clavate, clamped. BASIDIOSPORES: 9.4-12.8 X 4-5µm, ellipsoidal to cylindrical or obscurely reniform to pip-shaped, inequilaterally flattened in profile, with a prominent apiculus hyaline, white in mass, amyloid. STIPE HYPHAE: 3-10µm diam., with narrower hyphae in the cortex than in the medulla, strongly pseudoamyloid, smooth, parallel, hyaline, clamped. CAULOCYSTIDIA: usually clustered, similar to the pileocystidia but less often with long pedicels and more often secondarily septate. BASAL MYCELIUM: slightly interwoven, agglutinated, 3-10µm diam., pseudoamyloid.

HABITAT, HABIT and SUBSTRATES: scattered on small broken pieces of woody angiosperm debris in predominantly Acadian coniferous forests of larch or spruce, fir and pine.

COLLECTIONS EXAMINED: CANADA: *New Brunswick:* Kouchibouguac Natl. Park, Aug. 11, 1977, R.L. Milikin (DAOM 169619), Sept. 24, 1977, J.E. & S.A.R. 2558 [type] (DAOM 166073), Oct. 9, 1978, S.A.R. 2753 (DAOM).

Resinomycena acadiensis can be distinguished from *R. rhododendri* by the larger spores, more distant lamellae and the more flaccid flesh. *Resinomycena kalalochensis* differs by its small stature, its more erect turf of capitate and scarcely resinous, secondarily septate pileocystidia and its geographic range. *Resinomycena montana* differs by its smaller usually narrower spores, smaller basidia, a coniferous substrate and its geographic range.

The glutinous to viscid stipes are a result of copious resinous exudates. These dry down to hardened masses in less humid situations creating a powdered appearance to the stipes. In herbarium specimens these masses become yellow with age.

Resinomycena brunnescens Redhead & Singer, *sp. nov.* Figs. 15-19.

Pileus 6 mm latus, planoconvexus ut depressus, rugulosus, brunneus. Lamellae adnatae vel subdecurrentes, bubalineae vel ochraceae. Stipe 20 mm long., 0.5 mm crassus, concolorus. Sporae 6.5-8 X 3.3-4µm, amyloideae, ellipsoideae. Pileocystidia 55-90 X 3-11µm, resinosa, clavata vel strangulata, vel nonresinosa ut dendroidea. Cheilocystidia 36-50 X 10-14µm, resinosa, clavata vel capitata, raris nonresinosa ut dendroidea. Tramate pseudoamyloideo.

Holotypus: DAOM 165884. Kouchibouguac Natl. Park, N.B., Canada, July 13, 1977, J.E. & S.A. Redhead 2336.

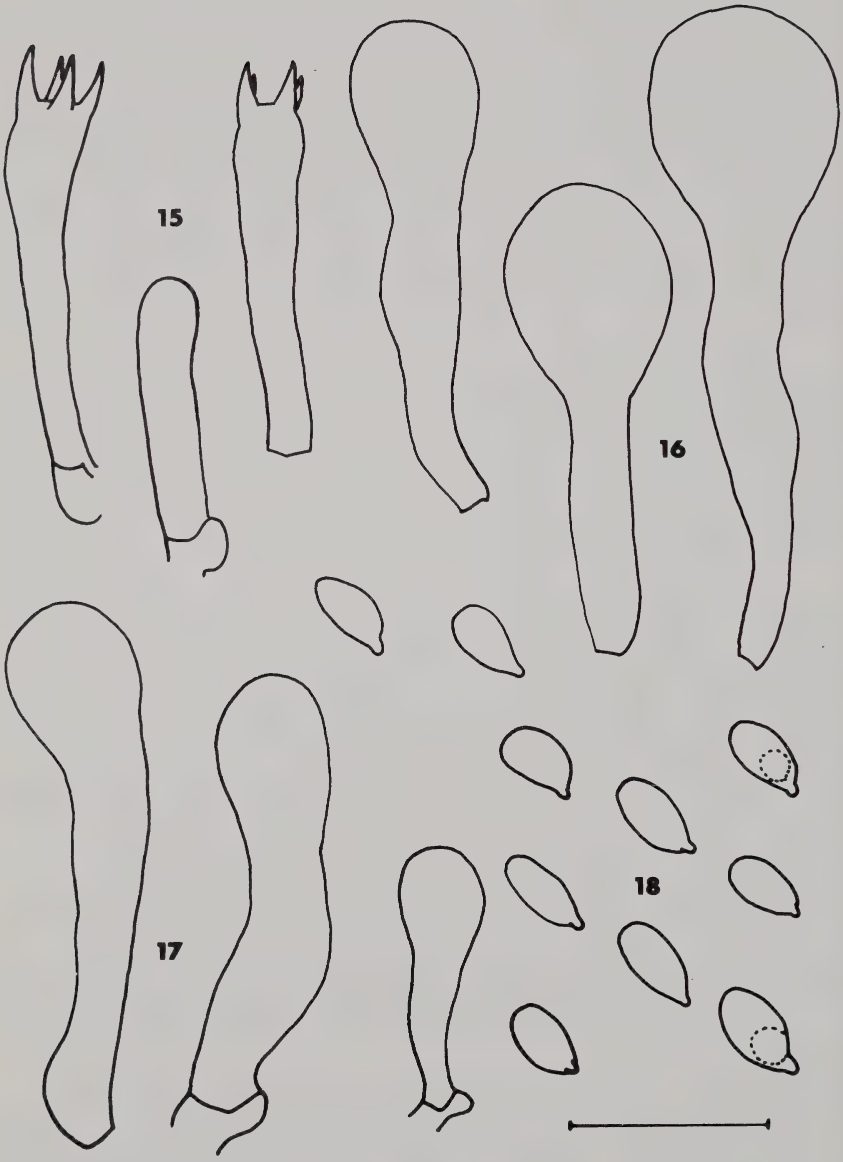
PILEUS: 6 mm wide, plano-convex and depressed centrally, rugose, tacky, scarcely translucent on edges, greyish sepia centrally, fulvous with ochreous to buff margins; context membranous, thin, concolorous above; odor not distinctive. LAMELLAE: adnate to subdecurrent, moderately spaced, buff to ochreous with whitish crenulate edges, sometimes forked; one tier of lamellulae. STIPE: 20 X 0.5 mm, concolorous with the pileus with the darkest pigments below, with a striated powdered appearance from dried resin, micaceous, attached to the substrate by a radiating white mycelial pad.

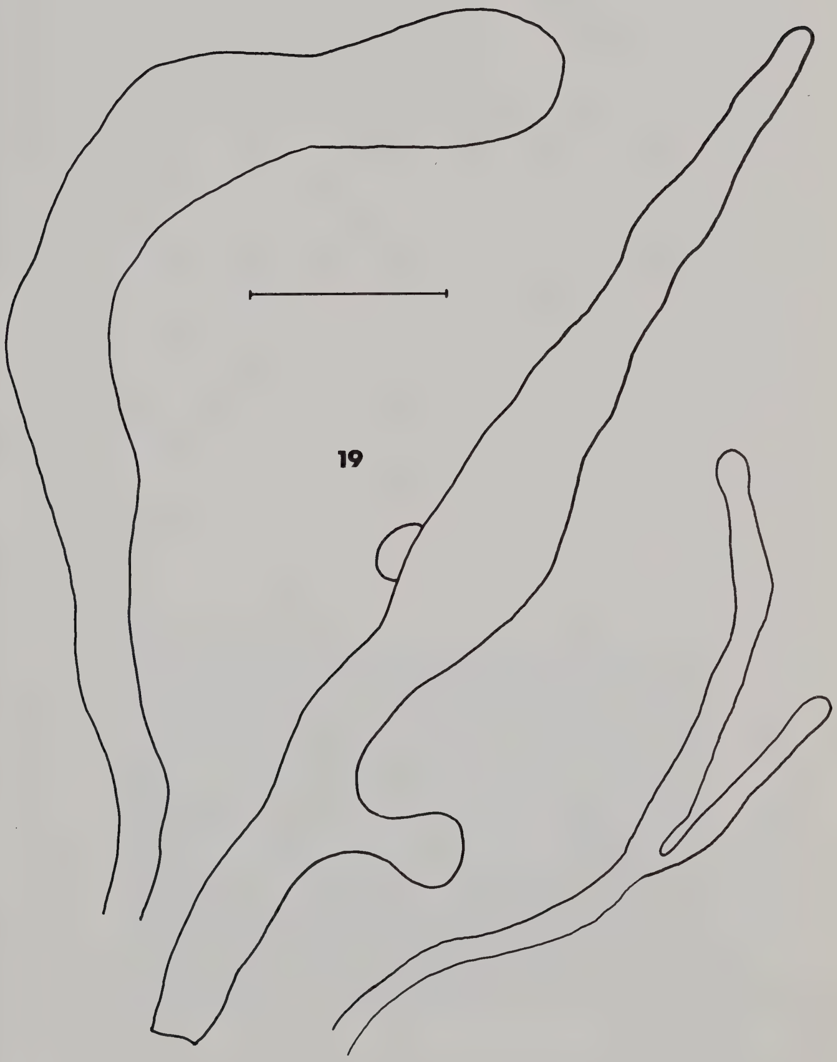
PILEAL EPICUTIS: a layer of tangled polymorphic cystidia 55-90 X 3-11µm, varying from clavate to fusoid often strangulate oleocystidia exuding copious resinous exudates to filiform often branched dendroid nonresinous forms. PILEUS TRAMA: duplex, with hyphae 10-15µm diam. subparallel, thin-walled, pseudoamyloid, yellowish brown and prominently incrusted with brownish resin-like materials in flat patches above, 5-10µm diam., hyaline, walls thin or pronounced below. LAMELLAR TRAMA: hyphae similar to those of the lower pileus trama. CHEILOCYSTIDIA: abundant, forming a sterile edge which on drying is a continuous hardened resinous line, 36-50 X 10-14µm, clavate and prominently capitate, hyaline, thin-walled. BASIDIA: 27-29 X 5-6µm, narrowly clavate (2-)4-spored, clamped. BASIDIOSPORES: 6.5-8 X 3.3-4µm, ellipsoid to obscurely obovoid or fusoid, hyaline, smooth, thin-walled, amyloid, with a prominent apiculus. STIPE HYPHAE: parallel, 3-5µm diam. in the cortex with pigments similar to the pileus tramal hyphae, 10-15µm diam. in the medulla, pseudoamyloid, clamped. CAULOCYSTIDIA: clustered, similar to the cheilocystidia but less swollen apically, occasionally forked, intermixed with a few dendroid filiform elements. BASAL MYCELIUM: not studied.

HABITAT, HABIT and SUBSTRATE: solitary on fallen leaf of *Rhododendron canadense* (L.) Torr. in a dense Acadian coniferous forest.

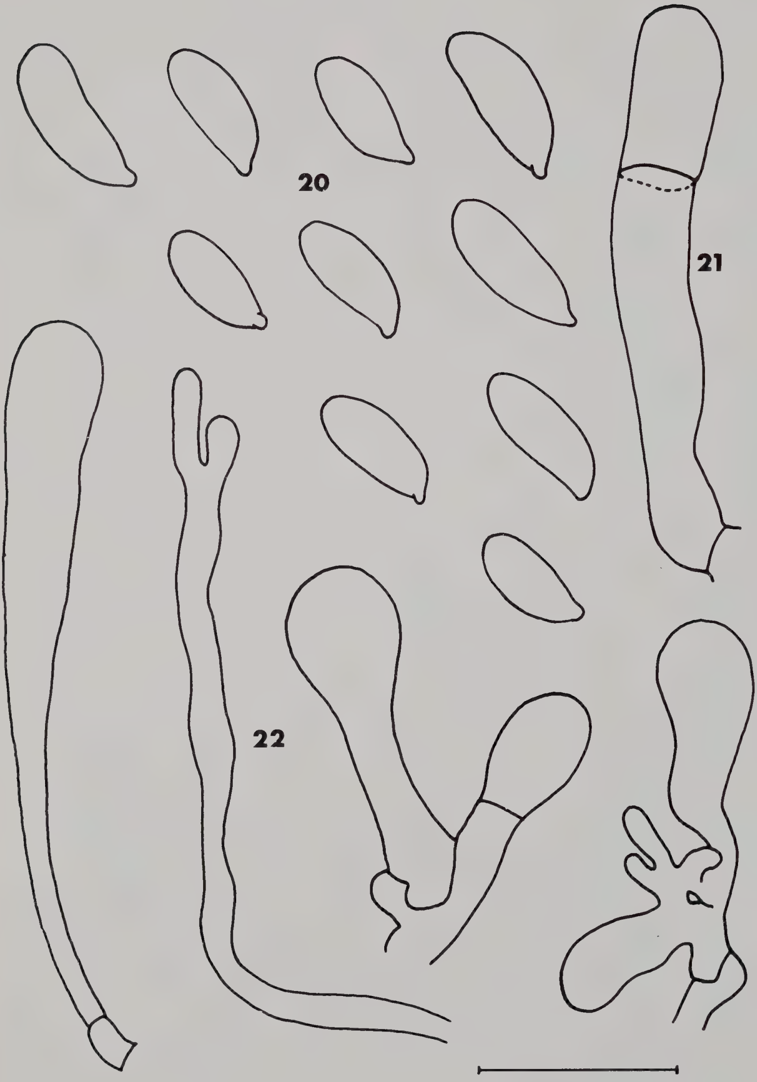
COLLECTION EXAMINED: CANADA: *New Brunswick:* Kouchibouguac Natl. Park, July 13, 1977, J.E. & S.A.R. 2336 [type] (DAOM 165884).

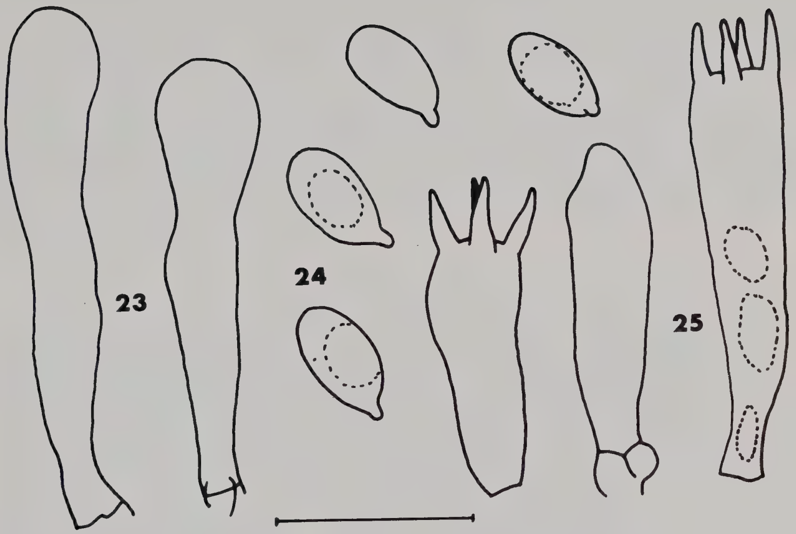
Resinomycena brunnescens is readily distinguished from all other species in the genus by its darkly pigmented pileus and stipe. The

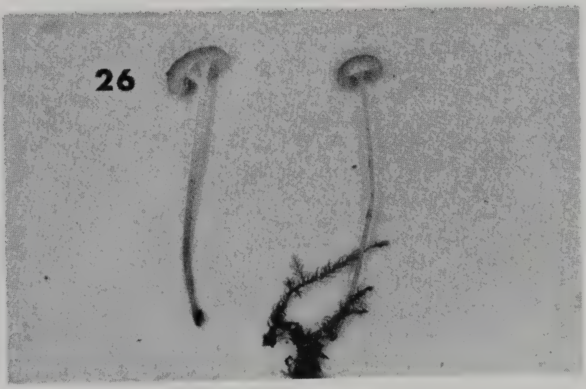




Figs. 15-19. *R. brunnescens* (DAOM 165884). 15, basidia. 16, cheilocystidia. 17, caulocystidia. 18, basidiospores. 19, pileocystidia.







Figs. 20-25. *R. acadiensis* (all DAOM 166073 except 24, DAOM 169619).
20, basidiospores. 21, caulocystidium. 22, pileocystidia.
23, cheilocystidia. 24, basidiospores. 25, basidia.
Scales = 15µm. 26, *R. montana* (DAOM 178214), carpophore, mag. X 2.

incrusted hyphae responsible for this darkened appearance are very distinctive microscopically compared to the nonincrusted hyphae in other *Resinomycena* species. In addition, *R. brunnescens* is characterized by very prominently capitate cheilocystidia which are inflated more than in any of the other species.

As noted above, Peck's original description of *Marasmius decurrens* is of a brown fungus. The existence of a brown species of *Resinomycena* in eastern North America suggests that Peck may have collected both *R. brunnescens* and *R. rhododendri*. However, this cannot be confirmed now.

GENERAL DISCUSSION

The three most probable generic depositories for *Resinomycena* if the taxon is not recognized as a distinct genus are *Hydropus*, *Mycena* and *Baeospora*, there being a foregone conclusion that the species are excluded from the genus *Marasmius* because of amyloid spores. The genus *Baeospora* as it was defined in *The Agaricales in Modern Taxonomy* (Singer, 1975) represents a small cohesive genus characterized by a number of characters, but in particular, small amyloid spores, inamyloid tramal tissues and crowded lamellae. *Resinomycena rhododendri* is the species most similar to a *Baeospora* in that it has close lamellae and small amyloid spores, however, the tramal tissues of the pileus and stipe are pseudoamyloid unlike any *Baeospora* species. Also the massed large oleocystidia mixed with dendroid elements on the pileus form a structure unlike any epicuticular formation found in *Baeospora*, including *B. pallida*. When all species of *Resinomycena* are taken into account, species such as *R. acadiensis* and *R. kalalochensis*, exhibit characters not found in *Baeospora* such as distant, slightly decurrent lamellae and large spores. As a result of these combinations of characters *Resinomycena* cannot readily be incorporated into *Baeospora*.

The genus *Hydropus* as defined by Singer (1975) contains species having numerous pileo-, cheilo- and caulocystidia and in some species pseudocystidia with oily contents. The spores can be amyloid and the tramal tissues can be weakly pseudoamyloid. Again the abundant oleocystidia on the pilei, stipes and lamellae of *Resinomycena* species, not found in *Hydropus*, in combination with intermixed dendroid elements form a tissue not found in *Hydropus* and clearly separate the genera.

The genus *Mycena* is treated as delimited earlier (Singer 1975). It includes species with amyloid spores, pseudoamyloid tramal tissues and oleocystidia as does *Hydropus*. The majority of *Mycena* species have an epicutis consisting of a repent layer of diverticulate narrow hyphae. Deviations occur in some sections of the genus where smooth repent filamentous hyphae replace the diverticulate elements. Those species which had smooth epicuticular hyphae bearing obtuse cystidia were removed to the genus *Hydropus*. The most aberrant type of epicutis for a species admitted to *Mycena* by Singer (1975) is found in *Mycena rorida* (Fr.) Kühner and its allies. These species have a hymeniform layer of sphaeropedunculate cells and, apparently missed by previous authors, in *M. rorida*, intermixed oleocystidia. Previously

(Singer 1975), it was indicated that these species were related to *Hydropus* and might need to be removed from *Mycena*. However, the strongly pseudoamyloid tramal tissues and a gelatinized stipe cortex weighed in favor of retaining the species in *Mycena*. Here again, the well developed layer of usually clavate oleocystidia and narrow dendroid elements found in *Resinomycena* is not typical of any section of *Mycena* and represents a large divergence from a typical *Mycena* type of epicutis. Furthermore, the typical *Mycenae* have characteristically broad (broader than *Resinomycena*) hypodermal and tramal hyphae; the hyphal cells often being short and voluminous. In a less restrictive delimitation of *Mycena* such as by Smith (1947) or Kühner (1938), *Resinomycena* would be included.

From the above discussion it can be seen that *Baeospora, Hydropus* and *Mycena* are open to emendation to encompass *Resinomycena* species but only by introducing a species group having an unusual combination of characters peripheral to the core of the genera involved. Instead the proposal to recognize a distinct genus seems more justified. *Resinomycena* species are obviously closely related to each other. They are readily distinguished from *Baeospora, Hydropus* and *Mycena* by the abundance of resinous oleocystidia intermixed with dendrohyphidia. The segregation of *Resinomycena* species maintains the integrity of the older genera, leaving them less heterogeneous and, therefore, more recognizable. There is no doubt that *Resinomycena* is closely related to *Baeospora, Mycena* and *Hydropus*. Obviously one solution would be to merge all three genera and add *Resinomycena*. Again there seems to be more merit in recognizing each of these genera including *Resinomycena*.

Finally, *Marasmius rhododendri* Singer (1947, 1936), a species described from Spain in the subalpine zone of the Pyrenees on *Rhododendron ferrugineum* L. is probably congeneric. The type (F) now consists of stipes only. Spores obtained from the type were amyloid although weakly in some and up to 12.5µm long. The stipe hyphae are pseudoamyloid and in an outer layer more or less gelatinized (the stipe was described from fresh material as somewhat shiny and viscidulous). They bear cystidia with dried incrustations similar to that found on *Resinomycena* species. In the original description (1936) yellowish incrustations were mentioned on the lamellar edges of vesciculose to ampulliform cheilocystidia ("echinulatis" possibly being an error in the 1947 description unless referring to dendroid elements).

The exact nature of these cystidia and the pileipellis could not be restudied in the damaged type collection and the identity of the species remains in doubt. The weakly developed collar is not found on the presently recognized *Resinomycena* species. This species should be restudied from fresh materials.

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SINOTERMITOMYCES, A NEW GENUS OF AMANITACEAE FROM YUNNAN, CHINA

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SUMMARY

Detailed analysis has led the author to propose the termitophilous **Sinotermitomyces** as a new genus, including two new species, S. **cavus** Zang and S. **carnosus** Zang. Both were collected in Yunnan, China. Type specimens of the two new species are deposited in the Herbarium of the Kunming Institute of Botany, Academia Sinica (HKAS).

The new genus Sinotermitomyces consists of two new species growing on termite combs. These edible fungi are distributed in subtropical and tropical regions of southwestern Yunnan. In Yunnan, professional collectors gather both Termitomyces and Sinotermitomyces in the rainy season from May to September, and dry preservation with salt and vegetable oils are used for building up a year-round supply (Cheo, 1942, 1948; Batra, 1979).

The genus Termitomyces in China is commonly found southward of the Yangtze. The distribution of Sinotermitomyces is in forests of the southwestern part of Yunnan. Specimens were collected by the author under Pinus khasya Royle ex Cord., Pinus yunnanensis Fr., and Castanopsis hystrix (Hk. f. & Thoms.) A. DC.

SINOTERMITOMYCES Zang, gen. nov.

Pileus conicus vel campanulatus, subconvexus vel papillatus, siccus, glaber vel scabridus. Lamellae subliberae, liberae vel adnatae, albidae. Stipes centralis, cavus, aequalis vel sub-fusoideus, carnosus, coriaceus vel fibrillosus. Annulus superus distinctus. Basidiosporae hyalinae, ellipticae vel obovatae, inamyloidea. Pleurocystidia ventricosa vel cylindrica, verrucosa vel tuberculosa. Cheilocystidia oblonga vel cylindrica, laeviuscula vel verrucosa. Fibulis nullis. Termiticola.

Typus generis: Sinotermitomyces cavus Zang.

Pileus conico-campanulate, subconvex and often with a prominent papillate apex, dry, never viscid, glabrous or scabrous. Gills free to almost free or adnate. Stipe central, often very long, variable in thickness, hollow, equal or subfusiform, fleshy or leathery or fibrillose. Annulus superus present, veil a pellicular veil that covers the gills in young specimens. Basidiospores from globose to ellipsoid, smooth, hyaline, inamyloid. Pleurocystidia present, cylindric or some fusoid-ventricose, covered with wart-like outgrowths. Cheilocystidia oblong to cylindric, smooth to warted. Clamp connections absent. The primordia develop in the holes of hypogeous termitaria.

This new genus can be distinguished from the genus Termitomyces Heim by the following characters: the small, subconvex pileus with prominent papillate apex; presence of veil remains on stipe and pileus; stipe leathery or fibrillose and hollow; pleurocystidia with sturdy, short processes (Heim, 1942; Singer, 1949).

1. **Sinotermitomyces CAVUS** Zang, sp. nov. (FIGS. 1-7)

Pileus 1-2.5 cm., conicus vel subconvexus, siccus, glaber, primo flavidus vel eburneus, demum fulvo-umbrinus vel rufo-brunneus. Lamellae subliberae vel adnatae, albidae vel eburneae, Stipes 20-30 cm. longus, 5-12 mm. crassus, aequalis, cavus, tubulosus, coriaceus vel fibrillosus, apice cicatricatus, sursam scabroso-furfuraceous, basim versus discoideus. Annulus superus distinctus. Basidiosporae 2.4-5 x 3.5-9 µm, hyalinae, globosae, ovoideae, ellipsoideae, laeves, inamyloideae. Basidia clavata, 15-25 x 10-14 µm, 4-sporigera. Pleurocystidia 12-20 x 25-45 µm, cylindrica vel clavata, verrucosa vel tuberculosa. Cheilocystidia 10-15 x 20-30 µm, oblonga vel cylindrica, tuberculosa. Fibulis nullis.

Hab. In sylvis praecipue Pinetis yunnanensi Fr. et Pinetis khasyae Royle ex Cord. nido Termitidarum (Odontotermes) erumpente.

Yunnan: Tengchung County, Tuan-Tian village, La-ba-qing. On nest of termites, in swampy grassland, under the pine woods above 2100 m. alt., 8. VIII. 1980. Li Xing-jiang **11.** (**Typus**, HKAS 6533); Tengchung County, Pu-Chuan village, 17. VII. 1979. Ma Xi-xiong **1, 2.** (HKAS 4612, 4613); Shweli County, Deng Ga, in pine woods, 13. VIII. 1980. Li Xing-jiang **22.** (HKAS 6568); Mangshi. 10. VIII. 1980. Zang Mu **06545** (HKAS 6545).

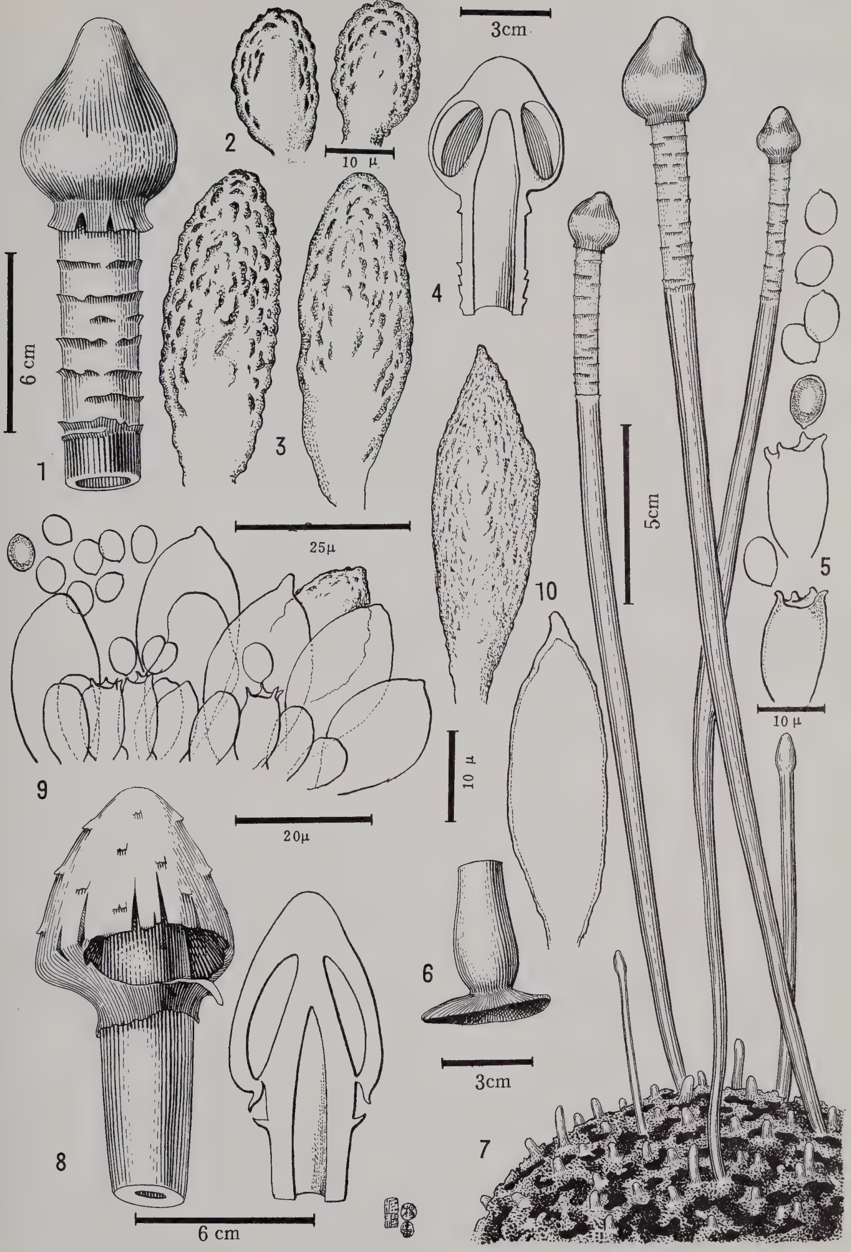
Pileus 1-2.5 cm broad, conical or subconvex, dry, glabrous, surface ivory white or pale yellow becoming yellowish-umber or reddish-brown towards the center, glabrous. Gills almost free or adnate, white to ivory white. Stipe 20-30 × 0.5-1.2 cm, equal, hollow, tube-like, leathery to fibrillose, upwards often covered with bran-like scales or scabrous and with a discoid base. Veil persistent as a thick, membranous leathery annulus, which is striate above. Basidiospores 2.4-5 × 3.5-9 µm, hyaline, globose, ovoid to ellipsoid, smooth, inamyloid. Basidia 15-25 × 10-14 µm, clavate, 4-spored. Pleurocystidia 12-20 × 25-45 µm, cylindric to clavate, covered with irregular wart-like outgrowths. Cheilocystidia 10-15 × 20-30 µm, oblong to cylindric, roughened. Clamp connections absent.

2. **Sinotermitomyces CARNOSUS** Zang, sp. nov. (FIGS. 8-10)

Pileus 4-6.5 cm., conicus vel campanulatus, demum plani-convexus, siccus, scabridus vel subtomentosus, primo albidus vel pallidus, demum cervinus vel brunneus. Lamellae subliberae vel adnatae, albidae. Stipes 15-20 cm. longus, 1-2.5 cm. crassus, subfusoideus, carnosus, cavus, concolorous, pseudorhizophorus. Annulus membranaceus, superus instructus. Basidiosporae 3-6 x 4.9-8 µm, hyalinae, globosae, ovoideae, ellipsoideae, laeves, inamyloideae. Basidia 9.8-12 x 14-18 µm, clavata, 4-sporigera. Pleurocystidia 10-18 x 24-48 µm, lageniformia vel fusiformia, exasperata vel verrucosa. Cheilocystidia 12-18 x 18-34 µm, rotunda, ovata, oblonga, laeviscula vel exasperata. Fibulatae adsunt.

Hab. In sylvis praecipue Castanopsitis hystricis (Hk. f. & Thoms.) A. DC. alt 1600-2100 m. nido Termitidarum erumpente.

Yunnan: Tsangyuan Autonomous County of Wa Nationality. On termites' nest. 30. VIII. 1980. Zang Mu **06752** (**Typus**, HKAS 6752).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6 cm

FIGS. 1–10, **Sinotermitomyces** spp. 1–7, **S. cavus** Zang (HKAS 6533). 1, 4, 7, carpophores; 2, cheilocystidia; 3, pleurocystidia; 5, basidia and basidiospores; 6, the discoid base of stipe. 8–10, **S. carnosus** Zang (HKAS 6752). 8, carpophores; 9, cheilocystidia, basidia, and basidiospores; 10, pleurocystidia.

Pileus 4-6.5 cm broad, conical, campanulate to plano-convex, dry, scabrous or subtomentose, surface white or pale white to waxy yellow or brown. Gills almost free or adnate, white. Stipes 15-20 × 1-2.5 cm, subfusiform, hollow, more fleshy, uniform in colour, pseudorhiza present. Annulus superior, fragments adhering to stipe. Basidiospores 3-6 × 4.9-8 µm, hyaline, globose, ovoid to ellipsoid, smooth, inamyloid. Basidia 9.8-12 × 14-18 µm, clavate, 4-spored. Pleurocystidia 10-18 × 24-48 µm, flask-shaped or fusiform, roughened with wart-like outgrowths. Cheilocystidia 12-18 × 18-34 µm, almost round, broadly oblong, almost smooth to roughened. Clamp connections absent.

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MYCOTAXON

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TYPE STUDIES IN THE POLYPORACEAE 13. SPECIES DESCRIBED BY J. H. LÉVEILLÉ.

by

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SUMMARY

Of the 145 polypores described by J. H. Léveillé 12 are accepted, 83 are synonyms, 6 names are invalid, 5 are an uncertain status, most of them Ganoderma sp., while 39 types were not found. The names of many of the missing types are accepted as synonyms based on notes by previous mycologists. The combination Tyromyces dissectus is proposed. The latter species and Trichaptum perrottetii are described in detail.

The French mycologist J. H. Léveillé was very industrious and described many fungi of which 145 are polypores. His basis was the collections in the Paris herbarium besides which he made a journey to Leiden and was allowed to take samples from the rich East-Asian collections of Junghuhn and Zollinger. Most of his collections are today in the Paris Herbarium (PC), but many of the polypore types are also in the Leiden herbarium (L.). Isotypes are at Kew (K), Stockholm (S), the Farlow herbarium (FH) and the National Fungus Collection (BPI).

Léveillé made very scanty labels, but often he fastened his specimens to the sheet with a red silky band attached both to the specimen and the sheet with a red lacquer. This made it possible to study both sides of the specimen without loosening it from the sheet.

This red lacquer has in many cases made it possible to trace some of his types when label and specimen have been separated, which was the case in many collections. Nevertheless, many of his types have been lost. However, both Lloyd (1912) and Bresadola (1916 & 1920) studied many of his specimens before they disappeared and it is possible to settle their identity. Léveillé described polypores in a number of genera, and they are treated in the genus in which Léveillé originally placed them. Within each genus the species are placed alphabetically according to their specific epithets. After the name there is a reference to where it was published and an indication of the herbarium in which the lectotype and eventual isotypes can be found.

The label is then cited in inverted commas and, if the text indicates no type locality, this is added in brackets. If the type was found to be a synonym this is indicated by = followed by a correct citation of the name in question.

When the species has been accepted, it is cited in its proper genus with a reference to a recent description, or described in detail if no modern description seems to exist.

DAEDALEA Fr.

D. aulaxina 1844:197. The type has not been found (Java).
= Lenzites vespacea (Pers.) Ryv. teste Bresadola (1916:230).
D. flavida 1844:198 (PC).
"Java". = Lenzites acuta Berk.
D. fuliginosa 1844:199.
The type has not been found (Mauritius).
D. lurida 1844:198 (PC, isotype in S).
"Java" = Lenzites acuta Berk.
D. microzona 1846:142 (L).
"Zollinger no 2060" (Java) = Lenzites acuta Berk.
D. plumbea 1846:142.
The type has not been found (Noveboracum = New York, USA).
D. pruinosa 1844:198 (PC, isotype in S).
"Ins. pacifico". = Lenzites acuta Berk.
D. splendens 1844:197.
The type has not been found (Sumatra).
D. violacea 1846:142.
The type is apparently lost (Cuba).

FAVOLUS Fr.

F. fibrillosus 1844:201 (PC).
"Manille" (The Phillipines). = P. phillipinensis Berk.
F. fissus 1844:201 (PC).
"Bresil, Rio de Janeiro, Mars 1836" = F. brasilensis (Fr.) Fr.
F. granulosus 1863:286 (PC, isotype in K).
"Chachi alt. 2600 m, Sept. 1860 Lindig 2919" (Colombia).
= Panellus pusillus (Lév.) Burds. & Miller.
F. guadeloupensis 1846:144 (PC).
"Guadeloupe, M. l'Herminier".

The type does not represent a true polypore and has probably been fleshy and gelatinous when fresh. Today it is resinous and horny. Pileus glabrous and pustulate, dark brown, pores shallow and angular, 1-2 mm wide, dirty to dark brown. Context dark brown and very dense. Hyphal system monomitic with clamps, variable in diameter, in parts inflated, 2-8 um wide, but difficult to separate. Spores and basidia not seen. The species is unknown to me.

F. junghuhnii 1844:202 (L, isotypes in PC & S).
"Ad truncos, in Insula Bantan" (The Phillipines). = P. phillipinensis Berk.
F. multiplex 1844:203 (PC, isotype in K & S).
"Java". = F. spatulatus (Jungh.) Lév.
F. peltatus 1844:203 (L, isotype in PC).
"Zollinger no. 707" (Java). = F. brasilensis (Fr.) Fr.
F. tener 1844:202 (L).
"Sumatra". = F. spatulatus (Jungh.) Lév.
F. tenuissimus 1844:202.
Type not found (Mauritius).

GLOEOPORUS Mont.

G. leptopilus 1844:194.
Type has not been found (Surinam).
G. pusillus 1844:195.

I have not found the type, but the species has generally been accepted as a poroid agaric. Modern descriptions can be found in Singer (1945:224) who placed the species in Dictyopanus, and in Burdsall and Miller (1978:85) who transferred the species to Panellus.

HEXAGONIA Fr.

H. blumei 1844:199 (PC).
"Java, Blume". = H. tenuis (Hook.) Fr.
H. cingulata 1844:200.
The type has not been located (Java).
H. cyclophora 1846:143 (PC).
"Mahe" (Tahiti). = H. tenuis (Hook.) Fr.
H. dregeana 1846:143 (PC).
"C.B.S. (Cape of Good Hope) Dreg. no. 17b." = H. tenuis (Hook.) Fr.
H. glabra 1846:143 (PC).
"Bombay (India), Polydore Roux". = Lenzites acuta Berk.
H. molkenboeri 1844:260 (L).
"Java, Junghuhn". = Lenzites vespacea (Pers.) Ryv. The synonymy was also noted by Bresadola (1916:231).
H. pulchella 1844:200 (L).
"Java". = H. tenius (Hook.) Fr.
H. tabacina 1854:17 (PC, isotype in K).
"Coll. Zollinger" (Java). = Cyclomyces setiporus (Berk.) Pat.

LENZITES Fr.

L. berkleyi 1846:122 (PC, isotypes in S & BPI).
"Grand bassin Saint Jean (Louisiana, USA) Mougeot no 36". = L. betulina (Fr.) Fr.

The type came from New York, but I have not found it. Bresadola (1920:66) had apparently examined it and indicated the synonymy given above. The cited specimen is selected as neotype until the lectotype reappears.

L. ciliata 1844:181.
No type has been found. No type locality was given.

L. guilleminiana 1846:122.
"Bresil meridional, Guillemin no. 1339" (PC). = *Stiptophyllum erubescens* (Berk.) Ryv.

L. junghuhnii 1844:180 (PC).
"ad truncos Java" Léveillé's hand. "Pour moi identique à *Lenzites betulina* L. *juvenile*" Bresadola's handwriting. = *L. betulina* (Fr.) Fr.

L. murina 1844:122 (PC, isotype in S).
"Java, Korthals". Selected as neotype. The type locality is given as Sumatra, but no such collection has been found. = *Trametes menziesii* (Berk.) Ryv.

L. myriophylla 1863:282 (PC).
"Voyage de J. Triana 1851-57. Novo Granata, Colombia". = *L. elegans* (Fr.) Pat.

L. platyphylla 1844:179 (PC, isotypes in NY & BPI).
"Java, ad truncos". = *Lenzites vespacea* (Pers.) Ryv.

L. platypoda 1844:180 (PC).
"Manille (The Phillipines)". = *L. elegans* (Fr.) Pat.

L. tenius 1846:122 (PC).
"Guadeloupe". = *L. elegans* (Fr.) Pat.

POLYPORUS Fr.

P. apalus 1848:124.
No type has been found. (Rentilly, France).

P. abnormis 1844:186.
The type has not been found (Java). = *P. sanguinaria* Kl. teste Lloyd (1910).

P.aculeatus 1846:137 (PC, isotype in BPI).
"Zollinger no. 2055" (Java). = *Trametes modesta* (Fr.) Ryv.

P. albomarginatus 1844:191 (PC, isotypes in BPI & L).
No text on label, except the name written by Léveillé. (Java). This is an accepted species in *Pyrofomes* as *P. albomarginatus* (Lév.) Ryv. For a description, see Ryvarden & Johansen (1980:529).

P. anisopilus 1844:191 (PC, isotypes in L & BPI).
"Java, Blume". = *Coriolopsis sanguinaria* (Kl.) Teng.

P. appositus 1846:141 (PC, isotypes in L & BPI).
"Zoll. no. 19. Auf faulen Baumen in Wald bei Tjiboda (Java) Mai 1842". This is an accepted species in *Phellinus* as *P. appositus* (Lév.) Pat. For a description, see Ryvarden & Johansen (1980:141).

P. atypus 1844:184 (PC).
"Guadeloupe, M. L'Herminier". = *Trametes modesta* (Fr.) Ryv.

P. auriculaeformis 1844:194 (L, isotypes in BPI and S).
"Java". = *Phellinus senex* (Nees & Mont.) Imaz.

P. blumei 1844:185 (L, isotypes in PC and BPI).
"Java, Zoll. no. 11" = *Trametes menziesii* (Berk.) Ryv.

P. bonplandensis 1846:301 (PC, isotype in BPI).
"Am equatoriale". = *Trametes membranaceus* (Fr.) Kreisel.

P. botryoides 1846:128 (S, isotype in BPI).
"Frag. orig. ex." (in Bresadola's hand) (North America). = *Globifomes graveolens* (Schw.) Murr.

P. bracypus 1846:127 (PC, isotype in BPI).
"Guadeloupe, M. L'Herminier, Février 1843". = Trametes marianna (Pers.) Ryv.

P. callimorphus 1846:133 (PC).
"Voyage de M. Perville N.O. de Madagascar 1841."
This is an accepted species in Phellinus as P. callimorphus (Lév.) Ryv. For a description, see Ryvarden & Johansen (1980:145).

P. callochrous 1844:181.
The type has not been found, and no type locality was given.

P. candicans 1863:285 (PC, isotype in K).
"Tequendama (Colombia), alt. 2600 m, Sept 1856, Lindig no. 2922". = Trichaptum biformis (Fr. in Kl.) Ryv.

P. candidulus 1846:301 (PC, isotype in K).
"Caesarodunum" (?) = Trametes cervina (Schw.) Bres. as already noted by D. Reid on the sheet.

P. chryseus 1846:301 (PC).
"Nouvelle Grenade (Colombia), M. Justin Goudot 1844.
This is an accepted species in Phellinus as P. chryseus (Lév.) Ryv. For a description, see Ryvarden & Johansen (1980: 151).

P. cinerascens 1844:184.
The type has not been located (Java).

P. cineraceus 1846:139.
The type has not been seen by me, but Bresadola (1916: 223, as "cinereus") reports the species to be a synonym of Trametes hirsuta (Fr.) Pil.

P. cohaerens 1846:132 (L, isotype in PC, BPI, FH and S).
"Zollinger no. 13" (Java). = Coriolopsis asper (Jungh.) Teng. as already indicated on the sheet in herb. PC by Bresadola.

P. confertus 1844:187 (PC, isotype in BPI).
"In truncos Java". = Coriolopsis asper (Jungh.) Teng.

P. connexus 1846:135 (PC).
"Brasil, Rio de Janeiro. M. Gaudichaud 1831-33".
As already indicated by Bresadola (1920:68) the type collection is mixed. One specimen is Coriolopsis caperata (Berk.) Murr. while another is Phellinus gilvus (Schw.) Pat. The description is so vague that it may cover both specimens, and thus, the name has to be rejected.

P. coriaceus 1846:137.
The type has not been found (Nelli Gherry, India). The name is invalid as a homonym of P. coriaceus Endl. 1830.

P. corrugatus 1846, 136 (L).
"Java". Invalid name, being a homonym of P. corrugatus Pers. 1826. The type of the invalid name is a specimen of Coriolopsis asper (Jungh.) Teng.

P. convolutus 1844:186 (PC, isotypes in L, S, NY and BPI).
"Java, Junghuhn". = Trametes menziesii (Berk.) Ryv.

P. cyathiformis 1844:181.
The type has not been found (Haiti).

P. demidoffii 1842:92 (S, isotypes in BPI and K).
"Frag. specimen orig. leg. Demidoff, comm. Patouillard".
This is an accepted species in Pyrofomes as P. demidoffii (Lév.) Kotl. & Pouz., for a description, see Ryvarden (1978:399).

P. dermatodes, see *Trametes dermatodes*.

P. dilitatus 1844:184 (L, isotype in S).
"Java, ex reliqui Junghuhnii". = *Trametes menziesii* (Berk.) Ryv.

P. disciformis 1844:193.
The type has not been found (Mauritius).

P. dissectus 1846:139 (PC).
"Herbier du Chile, donné par M. Gay".

This is a *Tyromyces* species, and the following combination is proposed: *Tyromyces dissectus* (Lév.) Ryv. comb. nov. Basionym: *Polyporus dissectus* Lév. Ann. Sci. Nat. Ser. 3 Vol. 5:139, 1846.

Fruitbody pileate, dimidiate with a contracted base, about 2.5 x 2.5 cm, base about 1 cm wide, 2-6 mm thick, fragile. Pileus applanate, margin fimbriate to distinctly split or lobed, surface white to dirty light brown, smooth, azonate, finely velutinate to almost glabrous in parts and weakly wrinkled radially. Pore surface light brown, pores 4-5 per mm, entire to slightly incised, tubes 2 mm deep, white. Context ochraceous, 1 mm thick.

Hyphal system monomitic, hyphae 2-5 um wide and with clamps, partly gelatinized in 2.5 % KOH, in Melzer with walls about 0.5 um thick, sparingly branched. Some hyphae have a dense yellowish protoplasm, distinct both in KOH and Melzer, 2-6 um wide and with scattered clamps, these hyphae may be interpreted as oleiferous or gloeopleurous. Cystidia and basidia not seen. Spores subcylindrical to oblong ellipsoid, hyaline, thin-walled and non-amyloid, 4-5 x 2-2.5 um. As long as only the type is known, the macroscopical characteristics have to be used with care.

This taxon may be the same as *T. floriformis* (Quel.) Bond. & Sing. Their microscopical characteristics are identical and the fruitbodies are similar. *T. floriformis* as collected in Europe is usually more pure white, but the darker colour of the type of *T. dissectus* is certainly due to bad preservation after it was collected in Chile and then sent to France.

P. dozyanus 1848:123.
The type has not been found (Java).

P. elatus 1846:129.
The type has not been found (Guadeloupe).

P. extensus 1846:129 (PC).
"Guadeloupe, L'Herminier". This is an accepted species in *Phellinus* as *P. extensus* (Lév.) Pat. For a description, see Ryvarden & Johansen (1980:158).

P. fastuosus 1844:190 (L, isotype in BPI).
"Singapore". The species is accepted in *Phellinus* as *P. fastuosus* (Lév.) Ryv. For a description, see Ryvarden & Johansen (1980:159).

P. fuscellus 1854:17 (L, isotypes in PC and K).
"Insul. Flores prope Balie". = *Coriolopsis asper* (Jungh.) Teng.

P. fuscus 1846:137 (PC, isotype in S & L).
"Zollinger no. 1454" (Java). The type is a specimen of what Berkeley later described as *P. setiporus*, a species

which usually is placed in *Cyclomyces*. The type species of the latter is *C. fuscus* Fr. 1833 making it illegitimate to transfer Léveillé's name to *Cyclomyces*. However, should anyone want to place the taxon behind Léveillé's and Berkeley's names in a genus other than *Cyclomyces*, then Léveillé's name has priority.

P. gaudichaudii 1846b:178 (PC, isotypes in S & BPI).
"Singapore 1839". = *Trametes menziesii* (Berk.) Ryv.

P. gayanus 1846:127 (PC).
"Chile, M. Cl. Gay. 1839". = *Trametes marianna* (Pers.) Ryv.

P. gibberulosus 1846:139 (PC, isotypes in K & FH).
"Guyana, Batara Reidweg, Wegel no. 568". = *Trametes villosa* (Hook.) Ryv.

P. gossypinus 1848:124 (PC, isotype in BPI).
"Ad truncos in Voges (France)". = *Tyromyces caesius* (Fr.) Murr.

P. guadeloupensis 1846:134 (PC, isotypes in S & NY).
"Guadeloupe, M. L'Herminier". = *Fomitopsis supina* (Fr.) Ryv. as already indicated by Bresadola on the original label.

P. haskarlii 1844:190 (L, isotypes in PC & BPI).
"Java". = *Phellinus pectinatus* (Kl.) Quel. as indicated on the sheet by Bresadola.

P. hasseltii 1844:187.
The type has not been found (Java).

P. heteromorphus 1846:123.
"Guyana". = *Amauroderma schomburgkii* (Mont. & Berk.) Torr., as already indicated by Furtado (1968:268).

P. hymenius 1863:283 (PC, isotype in K).
"Cune M. 1100 Juillet 1860" (Colombia). = *Coriolopsis brunneo-leuca* (Berk.) Ryv.

The type is unfortunately sterile. I have not seen the species fertile from the neotropics, and the dextrinoid reaction found in the skeletal hyphae of many African specimens was not seen in Léveillé's specimen. It may be that two macroscopically similar species are involved. Fertile material from the neotropics may shed some light on the problem.

P. inquinatus 1846:140 (PC, isotypes in FH & BPI).
"Perrottet, Nelli Gherry, India orientalis". = *Trichaptum biformis* (Fr. in Kl.) Ryv.

P. kickxianus 1848:122.
The type has not been found (America).

P. korthalsii 1844:190 (L).
"Sumatra, Korthals". = *Phellinus senex* (Nees & Mont.) Imaz.

P. lenis 1848:123 (PC, isotype in BPI).
"America, ad truncos". = *Coriolopsis polyzona* (Pers.) Ryv.

P. lenziteus 1854:17 (L, isotype in PC).
"Zollinger 975 (Sumatra)". = *Lenzites acuta* Berk.

P. leucomelas 1846:140.
The type has not been found. Invalid name, non *P. leucomelas* Pers. 1825.

P. lindigii 1863:283 (PC, isotype in K).
"Teguendama (Colombia) Canoas alt 2600. Sept. 1860".

= Trametes cfr. modesta (Fr.) Ryv. The collection is fertile with spores 6.5-8 x 3-3.5 um. These measurements are in accordance with those of Fidalgo & Fidalgo (1968:27). The spores of the paleotropical taxon called T. modesta and macroscopically identical with that of the neotropics, are seemingly smaller. However, a richly fertile specimen has never been found and no sporeprint has been made.

P. longipes 1846:124 (PC; isotype in BPI).
"Guyane francaise". This is an accepted species and the type of Haddowia, Stey. in the Ganodermataceae. For a description, see Ryvarden & Johansen (1980:93) with further references.

P. macropus 1848:122.
The type has not been found (Java).

P. mangiferae 1846:130 (PC).
"Voayge de M. Perville. N. East de Mahe (Tahiti) 1841". The species belongs in Ganoderma and its final status has to be decided when the genus has been revised.

P. manubriatus 1854:17 (L).
"Zollinger 974" (Sumatra). = Microporus scopulosus (Berk.) Ryv.

P. marchionicus 1846:300.
The type has not been found (Marquesas Islands).

P. mastoporus 1846b:176 (PC).
"Singapore, Février 1832". This is a Ganoderma species in the G. lucidum complex. Its status has to be settled when the genus is revised.

P. megaloma 1846:128.
The type has not been found (New York, USA). In American literature it is commonly assumed that this is the same as Ganoderma applanatum, see Overholts (1953:99). From the description it is very probably so.

P. melaneus 1846:131 (L, isotypes in S & BPI).
"Zollinger no. 2085 (Java)". = Coriolopsis caperata (Berk.) Murr.

P. melanaleucus 1846:141.
The type has not been found (Réunion).

P. microcyclus 1844:188 (L, isotypes in PC, K, NY & BPI).
"Java". = Cyclomyces tabcinus (Mont.) Pat.

P. microloma 1844:183.
The type has not been found (Manilla, The Phillipines). At Kew there is a specimen: "Phillipines 1908, Curran, cum typo comparato" ink, Bresadola's hand. This is a specimen of Microporus affinis (Nees & Blume ex Fr.) Kunt. The specimen mentioned above is selected as neotype until authentic material is found.

P. moritzianus 1846:130 (L).
"Zollinger 360 (Java). = Trametes marianna (Pers.) Ryv.

P. murinus 1844:185 (L, isotypes in PC and FH).
"Java". = Trametes menziesii (Berk.) Ryv.

P. nephelodes 1846:125.
The type has not been found (Paramaribo, Brazil). In the Stockholm herbarium there is a specimen: "182 P. nephelodes Lév. = Polyp. flabelliform. Kl. transiens Java v. Höhnel" Bresadola's hand. The specimen is Microporus affinis (Blume et Nees ex Fr.) Kunt. However, as the genus Microporus is not known from South America,

the specimen from Java cannot be selected as neotype of *P. nephelodes*.

P. nordmannii 1842:93.
The type has not been found (Korbek, USSR). Fries (1874:581) refers the species to *Heterobasidion annosum* (Fr.) Bref. but it is not stated whether he had seen the type or based his suggested synonymy on the description alone. The latter is rather vague, but could apply to a resupinate specimen of *H. annosum*.

P. notopus 1844:194 (PC).
"Java". = *Trametes modesta* (Fr.) Ryv.

P. ostreatus 1846:127 (PC, isotype in BPI).
"Bresil, Rio de Janeiro, M. Gaudichaud 1831-33". = *Trametes cubensis* (Mont.) Sacc.

P. pala 1844:183.
The type has not been found (Surinam).

P. pectunculus 1846:138 (PC).
"Indes orientalis, Nelli-Gherry (India)". = *Trametes versicolor* (Fr.) Pil.

P. perpusillus 1844:191 (PC).
"Am. Boreal". = *Fomitopsis scutellata* (Schw.) Bond. & Sing.

P. phaeus 1846:132.
The type has not been found (Sri Lanka).

P. placopus 1846:124 (S).
"Java, Junghuhn". This is a *Ganoderma* sp. in the *Ganoderma lucidum* complex. Its status has to be settled when the genus is revised.

P. platypilus 1844:192.
The type has not been located (Java).

P. plumbeus 1846:136 (PC, isotype in S).
"Guadeloupe, M. L'Herminier". = *Rigidoporus fusco-lineatus* (Pers.) Ryv.

P. rhodophaeus 1844:190 (S).
"Java". This is an accepted species in *Fomitopsis* as *F. rhodophaeus* (Lév.) Imaz. For a description, see Ryvarden & Johansen (1980:340).

P. rigidus 1844:189 (L).
"Java, Zollinger no. 732". = *Nigroporus durus* (Jungh.) Ryv.

P. rudis 1846:133 (PC).
"Guadeloupe, M. L'Herminier". Invalid name, non *P. rudis* Berk. 1839. The type of the invalid name is *Fomitopsis supinus* (Fr.) Ryv.

P. rugulosus 1844:189 (L).
"No. 57" (Java) (leg. Junghuhn?). = *Coriolopsis sanguinaria* (Kl.) Teng.

P. sclerodermus 1846:129 (PC).
"Guadeloupe, L'Herminier". = *Fomes fasciatus* (Fr.) Cooke.

P. scleropodius 1846:123 (BPI).
"Ile Bourbon (Réunion)". = *Lignosus sacer* (Fr.) Ryv.

P. sericellus 1846:125.
The type has not been located (Sri Lanka).

P. sideroides 1844:182 (PC, isotype in K).
"Sumatra". This is an accepted species in *Coltricia* as *C. sideroides* (Lév.) Teng., for a description, see Ryvarden & Johansen (1980:112). Léveillé named also Coll.

Zollinger No. 90 as P. sideroides, but this collection is a specimen of Phylloporia chrysita (Berk.) Ryv. Duplicates of this collection have been seen in herb. L, S, FH, PC and BPI.

P. sordidus 1844:192 (PC, isotype in S).
"Guadeloupe, L'Herminier". = Trametes modesta (Fr.) Ryv.

P. splendens 1844:187 (PC, isotype in L).
"Java". = Trametes modesta (Fr.) Ryv.

P. spurcus 1846:135 (PC, isotype in S).
"Guadeloupe, L'Herminier". = Phellinus gilvus (Schw.) Pat.

P. stevenii 1842:91.
The type has not been seen. Lloyd (1915:285) indicates it to be Ganoderma applanatum based on the original description and plate. Donk (1974:67) agreed, and I subscribe to the conclusion.

P. subflavus 1846:300 (PC).
"Nouvelle Orleans, Salle". = T. versicolor (Fr.) Pil.

P. swartzianus 1846:132.
The type has not been found (Jamaica).

P. tegularis 1846:131 (PC, isotype in FH).
"Zollinger 2054 (Java)". = Trametes scabrosa (Pers.) Cunningh.

P. tenax 1846:139.
The type has not been located (Tequendama, Colombia).

P. tener 1846:139 (PC).
"Guadeloupe, M. L'Herminier". = Trametes villosa (Hook.) Ryv.

P. tenuissimus 1844:188.
The type has not been found (Java, leg. Korthals).

P. testaceus 1846:126 (PC).
"Brasilia meridionalis, Dupré, 1842". This is a Ganoderma sp. in the G. lucidum complex. Its status has to be settled when the genus has been revised.

P. trachodes 1844:192.
The type has not been found (Java).

P. tricolor 1846:134.
The type has not been found (Bahia, Brazil).

P. trigonus 1846:134 (PC).
"Zollinger No. 2069 (Java)". = Coriolopsis sanguinaria (Kl.) Teng.

P. tristis 1846:126 (PC, isotype in FH).
"Zollinger No. 2035 (Java)". Invalid name, non P. tristis Pers. 1825. The type of Léveillé's invalid species is a specimen of Nigroporus vinosus (Berk.) Murr.

P. unguiformis 1846:138 (PC, isotype in FH).
"Zollinger No. 1437, Tjiboya (Java)". = Rigidoporus microporus (Fr.) Overeem.

P. vulneratus 1844:188 (PC).
"Ad truncos, Java". = Coriolopsis sanguinaria (Kl.) Teng.

P. zollingerianus 1846:131 (PC, isotypes in S and FH).
"Zollinger 1386 (Java)". = Trichaptum byssogenus (Jungh.) Ryv.

SISTOTREMA Fr.

S. ochroleucum 1846:145 (PC).
"Bombay (India), Polydore Roux" = Lenzites acuta Berk.

TRAMETES Fr.

T. acuta 1844:196.
The type has not been located (Sumatra). Specimens determined by Bresadola in herb. S and BPI are all Coriolopsis strumosa (Fr.) Ryv., and this was probably also Léveillés concept.

T. crassa 1844:197 (K).
"Madagascar". = Hexagonia hirta (Fr.) Fr.

T. dermatodes 1844:196 (PC).
"Voyage de M. Gaudichaud sur la Bointé. 1836-37. Manille (The Phillipines)". = Oxyporus cervino-gilvus (Jungh.) Ryv. as already indicated by Reid (1953:135).

T. incana 1844:196 (BPI).
"Manille (The Phillipines)". This is an accepted species in Trametes, for a description, see Ryvarden & Johansen (1980:565).

T. perrottetii 1844:195 (PC).
"Guyane francaise M. Poileau" (printed on the label). "Java, M. Perrottet", unknown handwriting. The name, however, is written by Léveillé.

There has been a mixing of labels or facts. The type represents a South American taxon which has never been found or reported from the paleotropics. The type is apparently the same specimen which was used by Montagne and Berkeley when they described Trametes trichomallus in 1849. The latter is the type of Trichaptum Murr.

Trichaptum perrottetii (Lév.) Ryv.
Norw. J. Bot. 19:237, 1972.
Fruitbody applanate, sessile, semicircular to elongated shelf-like, mostly broadly-attached, usually not decurrent on the substratum, 5-15 cm long, 3-7 cm wide and to 8 mm thick (tomentum not measured), tough and flexible. Pileus with a dense, strigose to villose or hirsute layer of forked hairs, dark brown, becoming darker towards the base and more greyish towards the margin, azonate or weakly-zonate, up to 10 mm thick at the base. Margin entire and sharp. Pore surface snuff brown, pores angular to round, first entire and thin-walled, 2-3 per mm, in older specimens often incised, coalescing and in parts sinuous to daedaleoid, in the latter case up to 2 mm wide and several mm long. Tubes deep brown, 2-5 mm deep. Context very thin, 0.1-0.4 mm, brown to dark ochraceous. Hyphal system dimitic, generative hyphae thin-walled, hyaline and with clamps, 2-4 um wide. Skeletal hyphae abundant, thick-walled to solid, mostly yellowish to light brown, 3-5 um wide. Cystidia abundant in the hymenium, clavate to ventricose with a tapering apex, smooth or with an apical crown of crystals, 10-18 um long, slightly projecting, basidia clavate 12-15 x 4-6 um and with 4 sterigmata. Spores subcylindrical to ob-

long ellipsoid, smooth, thin-walled and non-amyloid, 5-7 x 2-3(3.5) um. On deciduous wood.

Specimens have been examined from USA, Cuba, British Honduras, Guatemala, Costa Rica, Colombia, Brazil, French Guyana and Bolivia.

T. vittata 1844:196.
The type has not been found (Sumatra).

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THE PUBLICATION DATE OF ARENDHOLZ'S THESIS ON LEAF-INHABITING HELOTIALES

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SUMMARY

July 7, 1979 is shown to be the date of effective publication of W.-R. Arendholz's doctorate thesis, "Morphologisch-taxonomische Untersuchungen an blattbewohnenden Ascomyceten aus der Ordnung der Helotiales," and the date of valid publication of the new taxa and new combinations proposed therein.

The status of publication of W.-R. Arendholz's Ph.D. thesis, entitled "Morphologisch-taxonomische Untersuchungen an blattbewohnenden Ascomyceten aus der Ordnung der Helotiales" was assumed to be "unpublished" by Korf and Kohn (1980). In order to protect the status of Arendholz's new names, they reported one as "an as yet unpublished new species referred to the genus ...." They had received in the mails from Arendholz a copy of his thesis (Arendholz, 1979), a soft-bound volume having the appearance of being some sort of photo-copy of the original typewritten thesis on deposit with the Universität Hamburg.

The purpose of this note is to call attention to the fact that over 180 copies of this thesis were actually distributed, and that in no way can the new names therein be ignored or treated as not validly published. On July 7, 1979, 139 copies were mailed by Arendholz to the

Staats- und Universitätsbibliothek, Hamburg, which subsequently distributed them to other libraries, and that date is held here to constitute the date of distribution constituting "effective publication" under the International Code of Botanical Nomenclature (Stafleu et al., 1978), Article 29.1. Twenty further copies were sent to the library of the Institut für Allgemeine Botanik der Universität Hamburg, and another 23 as gifts to scientists in different countries. Approximately 20 additional copies are still in Arendholz's possession out of a photo-offset lithography press run of some 200 copies.

While it seems unfortunate that the copies that were distributed carry no indication of the exact date of distribution, nor even that the volume constitutes a publication in the sense of the Code of Nomenclature, recent articles on effective publication under Articles 29-31 of the Code leave no doubt in our mind that the thesis was effectively published. The four articles in Taxon **29**(4), the August 1980 issue, support our position [Brummit (1980); Hara and Eichler (1980); Nicholson (1980); Weresub and McNeil (1980)].

Since the thesis is printed by photo-offset lithography, it must apparently be accepted as printed matter (Art. 29): "... it may safely be assumed that matter produced by a conventional typewriter, consisting of one top copy plus one to several carbon copies, is not considered to be printed. On the other hand, copy originally produced on a typewriter and then reproduced by offset lithography (as for example the important taxonomic journal Mitteilungen der Botanischen Staatssammlung München) must certainly be accepted as printed matter" (Brummitt, 1980: 477-478).

The Code (Art. 29.1) requires that the printed matter be distributed "to the general public or at least to botanical institutions with libraries accessible to botanists generally." Neither the number of copies, nor the number of libraries (nor even that they be located in more than one country) is stipulated in the Code, "and presumably in an extreme case a printed work distributed to as few as two libraries should be taken as effectively published" (Brummitt, 1980: 479).

In the case in point, the requirements for effective publication would have been fulfilled by mere deposition of one copy of the printed thesis in the "Staats- und Universitätbibliothek" and one in the library of the "Institut für Allgemeine Botanik." As noted above, many more than two copies were distributed to several libraries and scientists worldwide. Nicholson's (1980) key similarly keys out this thesis as "effectively published."

Establishing an exact date of publication of any printed work is critical for nomenclatural purposes. For journals, the practice is to use the actual date of mailing of each issue as publication date [this is the procedure with MYCOTAXON, as it is also with MYCOLOGIA (C.T. Rogerson, Managing Editor, pers. comm.)]. Similarly, commercial books are published on the date they are "actually offered and available for purchase, not that on which they actually reach the public or libraries" (Brummitt, 1980: 480). Since the bulk of the copies of Arendholz's printed thesis were mailed on July 7, 1979 to the Staats- und Universitätsbibliothek, Hamburg, that date should now be accepted as the date of publication of the thesis for all nomenclatural purposes.

Various proposals by Hara and Eichler (1980) and by McNeil (in Weresub and McNeil, 1980) focus on the kind of problem presented by Arendholtz's thesis with a view to eliminating any problems in the future, with worthwhile suggestions for requiring an indication of intention to offer material as "published" under the provisions of the Code, requirements for deposition in a specific number of (named) institutions, and indication of actual date of publication (distribution). Such proposals will be useful in the future, but in any case will not be retroactive, but apply from 1982 onward if they are adopted at the International Botanical Congress in Sydney later this year in the forms submitted.

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AN ALTERNATIVE VIEW OF CERTAIN TAXONOMIC CRITERIA USED IN THE ENTOMOPHTHORALES (ZYGOMYCETES)

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SUMMARY

Long-standing unresolved controversies about the various generic classifications of the entomopathogenic Entomophthorales require a review of the validity and the relative weights of the morphological and other taxonomic criteria used to construct a useful classification for this group. Major morphological criteria used in the Batko and Remaudière classifications are evaluated here in a survey of the taxonomic distributions of these characters and the significance of the irregularities in their distributions.

The number and nature of nuclei in the primary spores, the branching of sporophores, and the mode of discharge of primary spores are regarded as the major characters suitable for delimiting genera. The presence of rhizoids and (to a limited extent) the shapes of primary spores are significant secondary generic characters. The presence of cystidia, mode of resting spore formation, and presence of capillary secondary sporophores are not regarded as characters of generic importance. The conidial or sporangial nature of primary spores is discussed, as are difficulties in the interpretation and applications of the terms *zygospore* and *azygospore*.

The applications of the generic names used in the Batko and Remaudière classifications are reviewed in light of the findings reported here. The validity of both *Strongwellsea* and *Entomophaga* is upheld, and the sense of *Erynia* is restricted to those species having branched sporophores and uninucleate bitunicate primary spores which do not form secondary spores on capillary sporophores. A nomenclatural problem is noted which indicates the synonymy of *Zoophthora* and *Erynia* if these genera are not retained as separate as proposed in the Remaudière classification. *Tabanomyces* is regarded as a synonym of the nematophagous genus *Meristacrum*.

INTRODUCTION

A far-reaching revision of the entomopathogenic genera of the Entomophthorales (Zygomycetes) proposed by Batko (1964a-e, 1966; Batko and Weiser 1965) has spawned considerable controversy among the students of these fungi. Even though there is now wide agreement that it is unsatisfactory to continue classifying approximately 150 diverse species in the single genus *Entomophthora* Fresenius, there has been no agreement regarding the appropriateness of the criteria used by Batko to restrict *Entomophthora* and to establish segregate genera or of the circumscriptions of these genera.

King and Humber (1981) offer a basic reconsideration of the major morphological characters of this group and discuss their taxonomic significance. While King and Humber evaluate the basic strengths and weaknesses of the Batko classification, they consider that no definitive reworking of the genera would be appropriate without a final resolution of the long-standing problem of delimiting *Conidiobolus* Brefeld from *Entomophthora* sensu lato.

More recently, however, a major reworking of Batko's generic classification by Remaudière and Hennebert (1980) and Remaudière and Keller (1980) — hereafter referred to as the Remaudière classification — resulted in generic assignments for some species which led to no manifest increase in the biological homogeneity of the recognized genera. Many taxonomic decisions in the Remaudière classification, and particularly those regarding the validity and importance of various characters used to construct classifications of these fungi, were presented without explanation and, in turn, have triggered further controversy and alternate views on classification (Ben-Ze'ev and Kenneth 1981a; Humber 1981a).

The time is appropriate to examine thoroughly those morphological and developmental characters which have been employed in the modern classifications proposed by Batko and by Remaudière and his colleagues. The values of these criteria are examined in the contexts of the available classification systems. Indeed, a sense of the relative values of their chosen criteria does emerge from a consideration of the major schemes of entomophthoralean genera and of the internal inconsistencies generated by the selection and ranking of the criteria accepted as valid in each of these generic schemes.

Despite its undisputed desirability, no general agreement regarding the generic classification of the Entomophthorales will be possible until the morphological and other criteria used in the past or being proposed now have been critically reviewed, evaluated, and agreed upon. This paper is the first in a series discussing the merits and weaknesses of the Batko, Remaudière, and other emergent classifications (*e.g.*, Ben-Ze'ev and Kenneth 1981a) in an attempt to find rational bases on which to build a generic scheme which (1) avoids the inconsistencies of the previous classifications of the Entomophthorales, (2) can accurately predict the natures of characters or aspects of the host-pathogen relationship, and (3) reflects what appear to be the evolutionary relationships among these fungi.

TAXONOMIC CRITERIA: ANALYSIS AND CONCLUSIONS

PRIMARY SPORES

Primary Spores: Conidia or Sporangia?

Throughout this paper I refer to *primary spores* or *spores* rather than to the more conventional *conidium* or the less common *sporangium* or *sporangiole*. *Conidium* and *sporangium* are terms referring to specific developmental patterns; their use should be for purposes of accuracy and must be backed by sufficient demonstration of the mode of sporogenesis. The reference to any asexual propagules in the Zygomycetes as *conidia* has been questioned by the students of the Hyphomycetes and Coelomycetes, although there is no reason to believe *a priori* that conidia cannot be formed by these or any other lower fungi. If appropriate studies of the origins and fates of the various wall layers of spores (and sporophores) during sporogenesis and germination prove that,indeed, they are conidia (or sporangia), then these propagules should be referred to as such. Similar studies are also needed for the panoply of secondary spore types produced in the Entomophthorales.

Spores containing single nuclei and borne on branched (or simple, in *Strongwellsea* Batko & Weiser emend. Humber) sporophores have caused much interpretational difficulty. These spores have a layer which, in liquid, lifts away from the spore surface and balloons outward. This has been regarded variously as a gelatinous coat (*e.g.*, *Entomophthora gloeospora* Vuillemin 1886) or, more frequently, as evidence for the sporangial nature of these fungi by regarding the detached layer as a sporangial wall enclosing a single sporangiospore (Thaxter 1888; Strong et al. 1960; Batko 1964b, 1974). This type of primary spore seems to be entirely restricted to the species of *Zoophthora* Batko, *Erynia* Nowakowski, and *Strongwellsea*. Kenneth (1977) claims that the outer wall of *Entomophthora turbinata* Kenneth [= *Neozygites turbinata* (Kenn.) Rem. & Keller, a generic assignment which remains debatable] lifts away but admits (personal communication) that this feature is doubtful and requires further investigation. If the spore of *E. turbinata* truly were bitunicate (with a separable outer wall layer), it would be the only instance of this character in a species with multinucleate spores.

Humber (1975; King and Humber 1981; Roberts and Humber 1981) notes ultrastructural evidence that the spore of *Strongwellsea magna* Humber, which has a separable outer wall layer, cannot be a monosporic sporangiole. The spore wall has no indigenous (sporangiospore) layer that is not shared with the sporophore itself. The separable layer is not a distinct (sporangial) wall, but represents only a separation of the outermost layer of the sporophore wall, all layers of which are continuous over the entire spore surface except for the papilla — which is covered only by an extension of the inner wall layer of the spore and sporophore (Humber 1975). This spore might be a true conidium, but this cannot be confirmed without also determining the fates of the wall layers during germination (see Dykstra 1974).

The only evidence for the occurence of sporangia in the Entomophthorales comes from several species of *Basidiobolus* Eidam, in which there are numerous instances when the cytoplasm inside a cell (usually but not always a spore) may be divided into several independent uninucleate units; *B. microsporus* Benjamin (1962) provides the most striking examples of this behavior.

I use the terms *unitunicate* and *bitunicate* introduced by Remaudière and Hennebert (1980) and Remaudière and Keller (1980) to refer to spores on which a separable outer wall layer is either absent or present, respectively. These terms are used almost exclusively within mycology to refer to the morphology (and function) of asci in the Ascomycotina, and constitute a primary character dividing the (bitunicate) Loculoascomycetes from all other (unitunicate) classes of this subdivision (Ainsworth et al. 1973). The use of these terms, however, should be generally accepted for the Entomophthorales since they (1) are convenient, (2) respect their etymological derivations, (3) should not be in any way confused with their applications for the ascomycetes, and (4) in the case of bitunicate spores, would help suppress the notion that such spores are sporangial in nature.

Morphology

The variety of shapes of primary spores in the Entomophthorales has been the source of much attention, particularly among those who have included nearly all entomopathogens of this group in the single genus *Entomophthora*. A series of artificial species groupings based on spore morphology have been proposed primarily to aid species identification (Lakon 1919; Hutchison 1963; Gustafsson 1965; MacLeod and Müller-Kögler 1970, 1973; MacLeod et al. 1976; Waterhouse 1975; Zimmermann 1978). None of these authors, however, intended their groupings to have taxonomic value. Remaudière and Keller (1980), however, chose the morphology of primary spores to be the main criterion for their generic classification.

Several genera do have characters of spore morphology which are unique to themsleves. One of the strongest and most valid criticisms of the Batko classification, in fact, was its separation of the species having campanulate spores (with relatively flat bases and a strongly apiculate apex) into *Entomophthora* sensu stricto and *Culicicola* Nieuwland depending upon the absence or presence of rhizoids. Remaudière and Keller (1980) rejected the significance of rhizoids for defining the genera, and redefined *Entomophthora* to include only species with this distinctive campanulate spore shape and associated mode of spore discharge (see MacLeod et al. 1976; Samson et al. 1979).

The spores of *Triplosporium* (Thax.) Batko (*nom. gen. conserv. prop.*, see Humber et al. 1981; = *Neozygites* Witlaczil) are variable in shape, but most often are round to slightly elongate and have a truncate rather than a conical or rounded papilla. As circumscribed by Batko (1964c), the spores of *Culicicola* species could be either campanulate (like those of *E. muscae* (Cohn) Fres.) or obpyriform with a smooth apex and rounded papilla; species with the former type were restored to *Entomophthora* s.str. while those with the latter type of spores were transferred to *Conidiobolus* by Remaudière and Keller (1980). King (1976b, 1977) regards *Conidiobolus* species to have round to pyriform primary spores, and notes the similarity of several entomopathogenic *Entomophthora* (sensu lato) species with *Conidiobolus*. Remaudière and Keller (1980) extended King's concept of *Conidiobolus* by transferring all entomopathogenic species with rounded to pyriform spores to that genus. The species of *Entomophaga* Batko have pyriform spores with a rounded apex and closely resemble the spores of *Conidiobolus* species. These two genera are unambiguously differentiated, however, by both the morphology and stain reactions of their nuclei (Humber 1981b).

The primary spores of *Zoophthora* Batko sensu Remaudière and Hennebert (1980) (= *Zoophthora* subg. *Zoophthora* Batko sensu Ben-Ze'ev and Kenneth 1981a) are rather cylindrical and usually taper apically to a blunt cone or a poorly defined point; just above the conical papilla, the spore flares to a very slight (but not always apparent) shoulder. The spores of *Erynia* Nowakowski species (see Remaudière and Hennebert 1980) display the greatest shape variation of any genus in the Remaudière classification. They range from elongate fusiform with a marked curvature and a shallow rounded papilla to somewhat cylindrical to ovoid or fusiform spores with rounded apices and papillae canted away from the spore axis. The spores of *Strongwellsea* species fit well within the range of morphological variation found in *Erynia*, a fact which seems to have motivated Remaudière and Keller (1980) to merge this genus into *Erynia*. The spores of *Empusa caroliniana* Thaxter, which Remaudière and Hennebert (1980) transferred to *Erynia*, are obovoid to pyriform, a shape corresponding more with those of *Erynia* spores than with any other genus.

Karyology: Number and Type of Nuclei

Early studies noting the taxonomic importance of entomophthoralean nuclei have been largely ignored (Vuillemin 1895; Cavara 1899a-b), so that no surpassing importance was attached to the number of nuclei in primary spores until the proposition of Batko's classification (1964a-d, 1966; Batko and Weiser 1965), which necessarily drew upon the observations of earlier workers regarding this cytological detail.

One of the most significant characters used by Batko (1964b) to establish *Zoophthora* was that of uninucleate primary spores, a character which is readily detectable and seems to be correlated well with the other characters of this genus. *Strongwellsea* Batko & Weiser (1965) was also described as having uninucleate spores but was clearly distinguished from *Zoophthora* by its simple sporophores and unique habit. *Erynia* Nowak. was split from *Zoophthora* by Remaudière and Hennebert (1980) and is circumscribed so as to allow multinucleate primary spores even though *E. caroliniana* is the only such species included in *Erynia* by Remaudière and his colleagues. As discussed at length below, the morphological characters of this species do not appear to belong in this genus, and its probable misclassification is clearly indicated by its status as the only species with multinucleate spores in this large grouping of species with uninucleate spores.

As is the case with branched sporophores (see below), there is a very low but natural incidence of abnormally developed primary spores. The spores of *Zoophthora*, *Erynia*, and *Strongwellsea* receive very nearly the entire cytoplasmic contents of the terminal cell of the sporophore. In species with branched sporophores there are, occasionally, larger than usual volumes of cytoplasm containing two (or three) nuclei which are isolated in a branch by its basal septum. The spore subsequently formed from this branch will be both markedly larger than normal and contain the extra nucleus or nuclei. Such exceptionally rare spores are clearly aberrant and cannot be used to invalidate the significance of uninucleate spores. Similarly, they do not justify the inclusion in *Erynia* (all of whose other species have uninucleate primary spores) of *E. caroliniana* (whose spores are always multinucleate and whose other major morphological characters do not match with the other species of *Erynia*).

Three genera are noted by Batko (1964a-b, 1974) to have plurinucleate spores. The spores of several *Entomophthora* species (sensu Remaudière and Keller 1980) contain 4-6 nuclei; those of *E. culicis* (Braun) Fres. are characteristically binucleate (or occasionally trinucleate) while those of *E. muscae* (Cohn) Fres. contain 5-8 nuclei. *Triplosporium* (= *Neozygites*) was described by Batko (1964b) to have quadrinucleate spores. Of the eight species included in *Neozygites* by Remaudière and Keller (1980), seven have 4-nucleate spores; *Entomophthora turbinata* Kenneth (1977) has spores with 5-7 or more nuclei. This deviation from the quadrinucleate condition of all other species in this genus indicates that close scrutiny must be given to the generic assignment of this relatively little studied fungus. On first examination, the only marked similarities of *E. turbinata* with the other species of *Triplosporium* are its simple sporophores and ovoid resting spores with a jet black epispore. Batko (1974) incorrectly indicated that the primary spores of *Massospora* Peck are binucleate; in fact, they vary from 1-6 (or more) nuclei, but most commonly contain 2-3 nuclei (Soper 1974, 1981).

The number of nuclei in spores of *Culicicola* species (as originally described by Batko 1964c-d) varied from pluri- to multinucleate, but really represent a bimodal distribution with either a few nuclei or many in the primary spores. This bimodal variation perfectly parallels the dispersal of *Culicicola* species for other reasons to either *Entomophthora* s.str. (plurinucleate) or *Conidiobolus* (multinucleate).

The taxonomic importance of nuclear morphology has not been appreciated until now even though some authors such as Batko (1964a-b, 1966; Batko and Weiser 1965) have drawn attention to the staining of nuclei in lactophenol/cotton or aniline blue or other stains, or to their general size and appearance, but never realized their porential taxonomic value. The large nuclei of *Basidiobolus* species, for example, have been the subjects of numerous cytological studies.

Humber (1981b) finds that nuclei of *Conidiobolus* species (sensu King 1976b) have relatively small nuclei with a prominent central nucleolus but no obvious heterochromatin; these nuclei remain unstained or only very weakly differentiated in lactophenol/aniline blue, aceto-orcein, or a number of other nuclear stains. The species of *Entomophthora* and most of the entomopathogenic genera have large nuclei with prominent heterochromatin but no large central nucleolus; these nuclei may be differentiated in lactophenol/aniline blue and are strongly and rapidly differentiated in aceto-orcein and other nuclear stains. This karyological criterion has proven to be of inestimable value for diagnostic work, particularly for distinguishing species of *Conidiobolus* from *Entomophaga* (whose primary spores are nearly identical in shape) or other genera with readily differentiated nuclei, and in determining incidences of double infections in insects when one of the fungi is a species of *Conidiobolus*.

Taxonomic Significance of Primary Spores

Batko's recognition of the generic significance of the number of nuclei (one, a few, or many) in primary spores has been widely embraced. The Remaudière classification, however, necessarily disregarded this character in order to place the greatest generic value on the shapes of primary spores. As will be made more apparent below, this dependence upon spore shapes is misplaced and leads to what seem to be several misclassifications which offer no improvement over earlier artificial schemes based on spore shapes and proposed without taxonomic or phylogenetic significance.

Nuclear cytology affords the only consistent and readily observed criteria which adequately distinguish the species of *Conidiobolus* from *Entomophthora* and its segregates (Humber 1981b). These criteria also uphold the validity of *Entomophaga* Batko for *E. grylli* (Fres.) Batko and several other species. *Entomophthora obscura* Hall & Dunn and *E. thaxteriana* (Petch) Hall & Bell were assigned to *Entomophaga* (Batko 1964d) but are now regarded as synonyms (see below); nuclear cytology confirms the transfer of *Entomophthora obscura* to *Conidiobolus* by Remaudière and Keller (1980).

The unitunicate or bitunicate nature of primary spores appears to be perfectly correlated with the nuclear number. With the sole unconfirmed exception of *E. turbinata*, all known bitunicate spores also contain a single large nucleus. Except for two species of *Massospora* in which uninucleate primary spores can occur (Soper 1974), all unitunicate spores are pluri- or multinucleate. It is possible that this distinction in wall structures of primary spores may assume a greater significance as more entomophthoralean fungi are found and described.

Among the characters related to primary spores in the Entomophthorales, then, generic value should be accorded to at least the number and nature of the nuclei in the spore. The shape and uni- or bitunicate nature of the primary spore should always be noted. However, while various states of these characters may coincide perfectly with the generic limits defined by other criteria, no reason is apparent at this time why either of them should be accorded generic value equal to nuclear number and morphology.

PRIMARY SPOROPHORES

Morphology and Branching

The branching of sporophores was one of the first criteria used to divide the entomopathogenic Entomophthorales into two genera (Brefeld 1873, 1877; Nowakowski 1883), and has continued to be one of the leading characters used by Batko (1964a-c, 1974; Batko and Weiser 1965) to construct a contemporary classification. The historical significance of sporophore branching as a character with generic importance demands careful review of both the reasons for and the effects of its de-emphasis by Remaudière and Keller (1980). It is necessary first to examine the systematic distribution of simple and branched sporophores and then to evaluate the exceptions to the normal state in each genus.

For any practical purpose, the sporophores are always simple in *Entomophthora* (although in *E. culicis* several sporophores may arise from each hyphal body, thus giving an impression of branching), *Massospora*, *Triplosporium*, and *Completoria* Lohde, a parasite of fern prothallia. *Tabanomyces* Couch et al. (1979; from tabanid fly larvae) and *Meristacrum* Drechsler (1940; from nematodes) produce an upright, unbranched sporogenous hypha which becomes septate and produces forcibly discharged spores on lateral (or terminal) papillae. *Ballocephala* Drechsler (1951; from tardigrades) also produces an upright, unbranched sporogenous hypha on which small lateral cells are formed from which the spores are budded and forcibly discharged. Sporophores in species of *Ancylistes* Pfitzer (Berdan 1938; from desmid algae) and *Basidiobolus* (Drechsler 1964) may occasionally branch; those of the 27 *Conidiobolus* species recognized by King (1976b, 1977) also may, on rare occasion, be bi- or trifurcate (King and Humber 1981). Among the species transferred to *Conidiobolus* by Remaudière and Keller (1980) the sporophores of *Empusa apiculata* Thaxter and *E. major* Thaxter may show some branching on rare occasion (see Thaxter 1888, Fig. 63), but are almost always simple. There is no significant branching in any *Entomophaga* species.

All species of *Zoophthora* s.str. (Remaudière and Hennebert 1980; Keller 1980; Ben-Ze'ev and Kenneth 1981a-b) have digitately branched sporophores with the possible exception of *Z. crassitunicata* Keller (1980) in which the sporophores appear in histological sections to be mostly simple.* All but three *Erynia* species (Remaudière and Hennebert 1980; Remaudière and Keller 1980; Kramer 1981) have digitately branched sporophores.

Within the bounds of the usual biological variation, it is not surprising that some species with simple sporophores occasionally have a small number of sporophores that show a low order of branching. Whatever branching occurs in these genera is usually basal rather than apical as in *Zoophthora* and *Erynia* (where the apical, digitate branching pattern usually results in the formation of a tightly interwoven hymenium). The infrequent occurences of branched sporophores in genera characterized by simple sporophores or of occasional simple sporophores in genera characterized by branched sporophores in no way indicates that this character should be de-emphasized or discarded.

The sporophores of *Zoophthora* and *Erynia* (apart from the three exceptions discussed below) do exhibit a variable degree of branching. Unbranched sporophores might occasionally be found on specimens from this large group of species in which nearly all sporophores are digitately branched. Similarly, species such as *Z. crassitunicata* may exist in which (digitately?) branched sporophores are less numerous than simple ones, but the affinities of these species with *Zoophthora* or *Erynia* will always be apparent from the natures of those branched sporophores, their primary spores, and other associated characters.

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* Keller's (1980) characterization of the sporophores of *Z. crassitunicata* as mostly simple seems to be based entirely on histological sections and should, therefore, be accepted as provisional until the publication of micrographs of carefully dissected pieces of hymenium showing whole sporophores of this species.

The natural degree of plasticity in the branching of sporophores in species of *Zoophthora* and *Erynia* does not imply, however, any real probability of finding species such as *Z. radicans* (Bref.) Batko (= *Entomophthora sphaerosperma* Fres.) or *Erynia neoaphidis* Rem. & Henneb. (= *Entomophthora aphidis* Hoffman sensu Thaxter) which form obviously digitate sporophores to yield an exceptional specimen in which a majority (much less all) of the sporophores are simple. It is even less feasible that a strain of such a species exists which produces branched sporophores when infecting most hosts but which forms only simple ones on one or more other hosts.

The uniform occurence of digitate sporophores in *Zoophthora* sensu Remaudière & Hennebert — including those (digitately?) branched sporophores of *Z. crassitunicata* — leaves only the two species of *Strongwellsea* and *E. caroliniana*, the three exceptional species placed in *Erynia* by Remaudière and his colleagues, to account for the de-emphasis by Remaudière and Keller (1980) of sporophore branching as a generic criterion.

It is important to examine why Remaudière and Keller (1980) supposed that a significant probability exists for finding branched sporophores in the two *Strongwellsea* species. It is these fungi which seem to form the basis for their de-emphasis of sporophore branching. The statement that branched sporophores are "not always present" in *Strongwellsea*, their primary justification for their opinion, seems to draw solely upon Strong et al. (1960) who note that the sporophores are "rarely branched" but who also admit the difficulty of tracing complete structures in their prepared slides. Batko and Weiser (1965) used some of these slides and correctly described the sporophores of *S. castrans* Batko & Weiser (1965) to be unbranched; they neither illustrated nor noted any exception to this simple state. Humber (1975, 1976) also found the sporophores of *S. magna* Humber to be *always* simple, and included this characterization in the emended generic description of *Strongwellsea*. The uniformly unbranched nature of sporophores in this genus reflects the means by which additional sporogenous hyphae interpolate themselves into and thus continually expand the surface area of the fungal ball in the host fly's abdomen (Humber 1975).

It has already been noted that *E. caroliniana* (with multinucleate and unitunicate spores, simple sporophores, and lack of rhizoids or cystidia) shares no major characteristics with *Erynia* species except for spore shape; the simple sporophores of this species do not constitute any significant exception to the common state of digitately branched sporophores in *Erynia*. However, some minor degree of branching of *E. caroliniana* sporophores may occur *inside* the host body, but the emergent sporophores are uniformly unbranched on the surface of affected craneflies (Thaxter 1888). Both Giard (1888, as *E. arrenoctona* Giard) and Keller (1978) also find the sporophores of *E. caroliniana* to be simple.

Several aspects of sporophore morphology — the presence and pattern of branching and the overall shape of the sporogenous cell or sporphore apex — should be considered to be important, but generic significance has usually been placed only on whether a sporophore is simple or branched. The sporophores of all *Entomophthora* species (in the strict sense) are markedly swollen and clavate below the spore, but this is the only genus in which this character is uniformly present. There is a less consistent tendency to produce clavate sporophores in species of *Zoophthora* or *Erynia*. In most other species and genera of the order, the apical portion of the sporophore is relatively cylindrical with only a slight tendency to become clavate.

Srinivasan et al. (1964) proposed to separate *Conidiobolus* from *Entomophthora* on the basis of sporophore shape. They suggested that *Conidiobolus* species have micronemous (hypha-like, indeterminate) sporophores while those of *Entomophthora* are macronemous (thicker than and distinctly differentiated from the vegetative hyphae, and of determinate length). This criterion was devised to separate *Conidiobolus* species from *Entomophthora muscae* (the type of its genus) and paid little attention to the many other species in *Entomophthora* sensu lato. In the more modern taxonomic systems considered here, the criterion proposed by Srinivasan et al. (1964) is applicable only to the few species of *Entomophthora* s.str. (Remaudière and Keller 1980); it is also untenable, however, since *Conidiobolus adiaeretus* Drechsler (see King and Humber 1981, Fig. 4f) and some other *Conidiobolus* species have markedly differentiated (macronemous) sporophores.

Several genera can, in fact, be distinguished in part by the exact morphology of the sporophore. *Basidiobolus* species have a more or less prominent swelling of the sporophore immediately below the spore, and the sporophore is markedly narrowed at the point where the spore is attached. Species of *Meristacrum*, *Tabanomyces*, and *Ballocephala* form several spores on each unbranched erect sporogenous hypha. The mode of spore production in *Meristacrum* and *Tabanomyces* is identical, and these genera are here considered to be synonymous (see below). The spores of *Ballocephala* are produced on globose to elongate lateral cells produced sympodially at the growing apex of the sporogenous hypha (Drechsler 1951; Richardson 1970; Pohlad and Bernard 1978). Three species placed in *Conidiobolus* by Remaudière and Keller (1980) — *E. apiculata*, *E. major*, and *E. papillata* Thaxter — differ from all other species of that genus (in the sense of King 1976b, 1977) by having an extended and neck-like narrowing of the sporophore apex; this morphological difference suggests that all characters of these fungi should be compared carefully with those of *Conidiobolus* before accepting their placement in this particular genus.

Taxonomic Significance of Primary Sporophores

The presence of branched or simple sporophores was regarded as a primary generic character in the Batko classification but was de-emphasized (and effectively rejected) in the Remaudière classification, seemingly to justify the synonymy of *Strongwellsea* (in which the sporophores are *always* simple) with *Erynia* (in which the usual case is for sporophores to be digitately branched). This de-emphasis and the elevation of spore morphology to a primary generic character by Remaudière and Keller (1980) further confused the classification by placing *E. caroliniana* (with simple sporophores) in *Erynia* and *Entomophthora carpentieri* Giard (apparently with branched sporophores, see below) in *Conidiobolus*.

As has been advocated by Ben-Ze'ev and Kenneth (1981a) sporophore branching should be re-instituted as a prime generic character. This restoration sweeps aside the apparent misclassifications of the Remaudière scheme by returning *Strongwellsea* to its rightful status as a separate genus (Humber 1975, 1976, 1981a), and leaving the placements of *E. caroliniana* and *E. carpentieri* undetermined and in need of further study.

For the entomopathogenic genera and *Conidiobolus*, the most taxonomically significant aspect of primary sporophores is only whether they are simple or branched. There does seem to be a significant difference, however, between a low level of basal branching (as in *Conidiobolus* and *E. caroliniana*) and the apically digitate branching restricted to the species of *Zoophthora* and *Erynia*. The means by which the primary spore or spores are produced on the sporophore and the morphology of the sporophore apex also assume taxonomic significance when considering the complete spectrum of entomophthoralean genera.

MODE OF FORCIBLE DISCHARGE OF PRIMARY SPORES

Three distinct mechanisms for the forcible discharge of primary spores are known from the Entomophthorales. Two of these mechanisms appear to be entirely restricted to single clearly defined genera while the predominant mechanism operates in nearly all the remaining genera. Primary spores are forcibly discharged in all generally recognized genera of this order except for *Massospora*, in which spores and hyphal bodies are passively dispersed from the disintegrating abdomens of the living host cicadas. All of the diverse types of secondary spores are also forcibly discharged except for those capillispores (see below) produced on long, narrow capillary sporophores.

All species of *Entomophthora* sensu stricto (Remaudière and Keller 1980) have campanulate and apiculate primary spores which are forcibly discharged on a stream of cytoplasm and vacuolar sap squirted from the sporophore as the wall layer(s) securing the primary spore to the sporophore break. The spore itself has a flat or slightly convex base rather than a distinct papilla, and appears to play no active role in the discharge process. Spores discharged in this manner are accompanied throughout their trajectories by a voluminous drop of the protoplasm which serves to affix the spore to the surface on which it lands, and forms a characteristic radially striate corona around the primary spore upon drying.

The primary spores of all species of the non-entomogenous genus *Basidiobolus* are borne on sporophores with a pronounced swelling immediately below the primary spore. Discharge occurs with a circumscissile rupture of the lower portion of the swelling; the spore and swollen upper portion of the sporophore fly away as the hydrostatic pressure in the upper portion of the sporophore is released backwards like a small rocket (Ingold 1934). Ingold's rocket analogy is strengthened by the fact that it is often possible to obtain the firing of a "second stage" as the small conical projection of the *Basidiobolus* sporophore into the spore itself may evert during flight, thus giving a slight push against the sporophore fragment and assuring a somewhat longer trajectory for the spore than for the sporophore fragment from which the spore becomes detached.

With the exception of *Massospora*, all other genera of the Entomophthorales apparently have primary spores discharged by the eversion of the spore's papilla against the sporophore (Gallaud 1905; Couch 1939). This mechanism depends upon the establishment of high turgor pressures in both the sporophore and spore prior to the rounding off of the turgid cell (Ingold 1971). The sporophore wall breaks at the point of spore attachment, and the spore papilla everts rapidly from its original position pointed into the spore and pushes the spore away from the turgid sporophore. The shock of this eversion against the pressurized water column of the sporophore sometimes causes a rupture of the sporophore tip and exudation of a water droplet at the time of discharge (*e.g.*, Page and Humber 1973).

Despite the lack of detailed understandings of these discharge mechanisms and of the involvements of the various wall layers of the sporophores and spores, it is apparent that spore discharge is a major event in the life history of an entomophthoralean fungus requiring the expression of a considerable portion of the genome. In view of the significance of this process for the fungus and the restricted distributions of the three diverse mechanisms, it is appropriate to recognize the mode of forcible discharge of primary spores as having taxonomic value at least on the generic level.

MODE OF SECONDARY SPORULATION

The general ability of entomophthoralean fungi to produce one or more types of secondary spores from primary spores is one of the most unusual features of this group of fungi. Among other fungal taxa, the Sporobolomycetaceae (heterobasidiomycetous "mirror" yeasts), many ascomycetes whose ascospores may bud repeatedly in the ascus, and some other entomopathogens such as a few species of *Septobasidium* Patouillard (Couch 1938) and the hyphomycetous genera *Muiogone* Thaxter (1920) and *Termitariopsis* Blackwell, Samson & Kimbrough (1980) may produce secondary spores. In none of these groups, however, has secondary sporulation assumed such a significant role as in the Entomophthorales. It is becoming increasingly apparent, for instance, that the secondary spore types are equally as infective as primary spores or that primary spores serve as dispersive units while the secondary spores produced from them may even be the major infective units (Carner 1976; Carner and Canerday 1968; Kramer 1980; Nemoto and Aoki 1975; Nemoto et al. 1979; Selhime and Muma 1966; Tsintsadze and Vartapetov 1976; Wilding 1970).

The morphological diversity (Batko 1974; King and Humber 1981) and biological importance of these spore types suggests that they might have taxonomic value above the specific level. In fact, two types of secondary spore forms — microspores and capillispores — have formed the bases for taxonomic divisions at subgeneric or generic levels in the Entomophthorales.

Microspores are produced when the primary spores of some *Conidiobolus* and *Basidiobolus* species produce a few to several dozen small secondary spores which are forcibly discharged and act individually as asexual propagules. The formation of microspores by *C. coronatus* (Costantin) Batko was first used to distinguish the genus *Delacroixia* Sacc. & Sydow; Tyrrell and MacLeod (1972) proposed that *Delacroixia* should be regarded as a subgenus of *Conidiobolus* to accommodate all species of that genus capable of forming microspores.

Capillispores (despite a profusion of names which are applied to them) are passively detached spores produced singly atop a thin and elongate (capillary) sporophore. Batko (1966) proposed to divide *Zoophthora* among four subgenera wil all species producing almond-shaped to elongate secondary spores on capillary sporophores to be restricted to the subgenus *Zoophthora* Batko. Remaudière and Hennebert (1980) restricted the genus *Zoophthora* to those species producing capillaries and capillispores and transferred all species remaining in the other three subgenera proposed by Batko (1966) to *Erynia* Nowakowski. In addition to their presence in all species of *Zoophthora* subg.*Zoophthora* sensu Ben-Ze'ev & Kenneth (1981a) or *Zoophthora* Batko sensu Remaudière & Hennebert (1980), capillispores are produced by all species of *Triplosporium* sensu Batko (but not *Neozygites* sensu Remaudière & Keller 1980), *Meristacrum* (including *Tabanomyces*; see below), and some species of *Conidiobolus* and *Basidiobolus*. Batko (1974) considers the presence of capillary sporophores to reflect an ancestral character of the Entomophthorales and rejects the possibility of their separate origins in these genera by evolutionary convergence.

If the Remaudière classification were prefectly evenhanded in its adoption of a generic criterion based on capillispores, then *Entomophthora turbinata* Kenneth (1977), which produces no capillispores, should not have been included in *Neozygites* by Remaudière and Keller (1980), and both *Conidiobolus* and *Basidiobolus* should have been split. It is curious that Remaudière and his colleagues apparently to not accept the parallel notion of splitting *Conidiobolus* because of the presence of microspores in some species of this genus.

Ben-Ze'ev and Kenneth (1981a) correctly reject the generic emphasis placed on capillispores by Remaudière and Hennebert (1980), and propose to use microspores and capillispores as a character with subgeneric validity as did Batko (1966) and Tyrrell and MacLeod (1972) before them. However, it is neither advisable nor even possible to apply criteria based on specialized secondary spore forms to all genera in which they might occur since *Basidiobolus microsporus* forms both microspores and capillispores (Benjamin 1962).

RHIZOIDS

Historical Perspective and Taxonomic Distribution

Batko's (1964a-c, 1974) placement of generic value on the presence of rhizoids has been one of the most troublesome aspects of his classification of the entomopathogenic Entomophthorales. His adoption of this criterion narrowed his circumscription of *Entomophthora* s.str. and led him to disperse the few species now regarded to belong in this genus (Remaudière and Keller 1980) among two genera. This misplaced emphasis also led him to propose *Culicicola* and *Entomophaga*, separated by the respective presence or absence of rhizoids, genera whose validity and circumscriptions have remained suspect due to the general controversy over the validity of rhizoids and to Batko's inability to provide a definitive separation of *Conidiobolus* from *Entomophthora* sensu lato.

Humber et al. (1977) re-evaluated and rejected the significance of rhizoids described for *Entomophthora virulenta* Hall & Dunn (1957; = *Conidiobolus thromboides* Drechsler; see Latgé et al. 1980). The rhizoids described for this fungus are now regarded to have belonged to another entomophthoralean fungus affecting the same aphids but which produced no spores or whose spores were undetected.

Remaudière and Keller (1980) and King and Humber (1981) independently discuss those species which usually form rhizoids but occasionally fail to do so. Note that all these exceptions represent the absence of (or failure to find) rhizoids in species normally producing them; they never involve observations of rhizoids in species not known to form them. Remaudière and Keller (1980) believe that no weight should be put on the presence of rhizoids because their presence "in certain species" is not always constant. On the contrary, King and Humber (1981) regard the presence of rhizoids to be taxonomically significant while their absence is not a dependable criterion.* Ben-Ze'ev and Kenneth (1981a) regard the presence of rhizoids to be taxonomically significant at the subgeneric level. Brobyn and Wilding (1977), in the most thorough consideration of the development of rhizoids and cystidia yet published, uphold the presence of rhizoids to be a taxonomically significant character.

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* Editorial changes of the text unintentionally altered this opinion to state that the absence of rhizoids is not taxonomically significant.

It is necessary to consider the general situation to know if any confidence should be placed on the presence (or absence) of rhizoids as a taxonomic characters. Even though no absolute scale is available to quantify one's level of confidence, it is necessary to weigh how well a species is known: How many times has it been found? In how many sites? From how many hosts? Are rhizoids always present or always absent? An examination of the taxonomic distribution of rhizoids among the entomophthoralean species reveals that many have never been found with them present. In only a few species, particularly *Zoophthora radicans* (= *Entomophthora sphaerosperma*), is the presence of rhizoids usual but inconstant. The absence of rhizoids might be explained in some instances by improper handling of specimens, but it is also possible that their formation on some insects might be a function of that particular host (Remaudière and Keller 1980; King and Humber 1981).

GENERA WITHOUT RHIZOIDS. Rhizoids are completely absent or have not been found in several genera. These include *Triplosporium* (at least 7 species), *Entomophaga* (at least 4 species although the circumscription of this genus remains in dispute), *Tabanomyces* (1 species; = *Meristacrum*), *Massospora* (13 species), and *Strongwellsea* (2 species). None of the non-entomopathogenic genera — *Basidiobolus*, *Ancylistes*, *Completoria*, *Meristacrum*, and *Ballocephala* — produce rhizoids.

ENTOMOPHTHORA (SENSU STRICTO). Two of the six species of *Entomophthora* s.str. (Remaudière and Keller 1980) produce rhizoids. This is the least constant appearance of this structure in any entomophthoralean genus. It can be said with assurance that rhizoids do not occur in the type species, *E. muscae*, since this is the most frequently observed of all species in the order. Both *E. culicis* (Braun) Fres. and *E. planchoniana* Cornu produce abundant rhizoids on hosts bearing forcibly discharged primary spores, but these anchoring structures may not occur when resting spores are formed. Both species are cosmopolitan in distribution and affect a wide variety of dipterans and aphids (respectively). All of the remaining species — *E. weberi* Lakon ex Samson (a little known species from a neuropteran), *E. thripidum* Samson & al. (1979; known only from thrips in Dutch greenhouses), and *E. erupta* (Dustan) Hall (which is known from several North American and European sites and hosts) produce no rhizoids and disperse their primary spores from living, mobile hosts. The same behavior occurs in the species of *Massospora* and *Strongwellsea*.

CONIDIOBOLUS. Among the 27 morphologically homogeneous species recognized by King (1976a-b, 1977), none is known to produce rhizoids; very few *Conidiobolus* species are currently known to be entomopathogenic. Remaudière and Keller (1980) transferred most entomophthoroid species with round to pyriform spores from *Entomophaga* (which was circumscribed to exclude species with rhizoids) and those species from *Culicicola* with round spores to *Conidiobolus*. All other *Culicicola* species have campanulate spores and were restored to *Entomophthora* by Remaudière and Keller (1980).

Among the 38 *Conidiobolus* species listed by Remaudière and Keller (1980), four produce rhizoids: *Empusa apiculata* Thax., *E. major* Thax., *E. papillata* Thax., and *Entomophthora carpentieri* Giard (1888). The first three species were placed in *Culicicola* by Batko (1964c-d) because of their rhizoids and multinucleate round spores borne on simple (or occasionally branched) sporophores. Their pronounced similarity to *Conidiobolus* species belies two obvious morphological differences from all other *Conidiobolus* species: the consistent formation of a few stout rhizoids ending in strongly differentiated holdfasts, and the nearly cylindrical, collar-like narrowing of the sporophore apex. Close study of these species will be required to verify if they actually belong in *Conidiobolus* as suspected by King (1976b) and affirmed by Remaudière and Keller (1980).

The only morphological character of *Entomophthora carpentieri* Giard (1888) fitting *Conidiobolus* is the round primary spore supposed by Turian (1957) to belong to this species. Several other characters of this fungus — the presence of rhizoids, uninucleate spores on branched sporophores (Turian 1957), and cystidia (Petch 1944, if Petch's belief that *E. coleopterorum* Petch and *E. carpentieri* are identical is correct) — correspond exactly with those of *Erynia* or *Zoophthora* in the Remaudière classification. *Entomophthora coleopterorum* (Petch 1944) has narrowly oval rather than round primary spores; the mode of rhizoidal attachment is identical with that of *E. carpentieri*, a species which Giard (1888) characterized only the the distinctive nature of its rhizoidal attachment. In a situation resembling that described above for the "rhizoids" of *C. thromboides*, one cannot discard the possibility that Turian (1957) may have observed the round spores of a secondarily invasive *Conidiobolus* species on a beetle which was already infected by *E. carpentieri* which was able to form its very characteristic rhizoids but no spores. No cytological staining or photomicrographic evidence supported Turian's contention that these round spores were uninucleate; it is possible that he mistook a central oil droplet or vacuole for a nucleus. The discrepancies between the Giard, Petch, and Turian concepts of *E. carpentieri* can be reconciled only after examining any existing herbarium material of these collections. In any event, however, the entire habit of this species refers it to *Erynia* or *Zoophthora* rather than to *Conidiobolus*.

ZOOPHTHORA. The presence of rhizoids is strongly correlated with branched sporophores bearing uninucleate, bitunicate primary spores — the species of *Zoophthora* Batko or *Erynia* Nowakowski. All eight *Zoophthora* species recognized by Remaudière and Hennebert (1980) form rhizoids. By including four newly described species, *Z. lanceolata* Keller (1980), *Z. crassitunicata* Keller (1980), *Z. orientalis* Ben-Ze'ev & Kenneth (1981a), and *Z. petchii* Ben-Ze'ev & Kenneth (1981b), the total rises to at least 11 of 12 species known to produce rhizoids. Ben-Ze'ev and Kenneth (1981a) remain uncertain if rhizoids were present on the few specimens of *Z. orientalis* available to them.

ERYNIA. Among the species listed by Remaudière and Hennebert (1980) and Remaudière and Keller (1980), some 21 of 25 *Erynia* species (excluding those of *Strongwellsea*) produce rhizoids. Together with *Erynia delphacis* (Hori) Humber*, *E. delpiniana* (Cavara) Humber**, and *E. ithacensis* Kramer (1981), the total incidence of rhizoids rises to 22 of 28 species. The absence of rhizoids in the six *Erynia* species discussed below is not considered to overturn the value of rhizoids as a secondary generic character although *E. delphacis* and *E. delpiniana* constitute the most notable of these exceptions.

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* *ERYNIA DELPHACIS* (Hori) Humber, comb. nov., basionym: *Entomophthora delphacis* Hori, 1906, Entomol. Mag. (Tokyo) *3*: 81.

** *ERYNIA DELPINIANA* (Cavara) Humber, comb. nov., basionym: *Entomophthora delpiniana* Cavara, 1899, Nuov. Giorn. Bot. Ital. (N. Ser.) *6*: 422.

Thaxter (1888) suspected that rhizoids were present on *Empusa virescens* Thax., but could not be certain since he was not the original collector of the material which he later used to describe this species.

Erynia aquatica (Anderson & Anagnostakis) Humber* is known only from mosquito larvae and pupae floating on the surface of temporary pools in the northeastern United States. This floating habit of the stricken hosts maintains their position for favorable transmission of the fungus without any "need" for rhizoids. This species is not known well enough, however, to say whether rhizoids might not form, for example, on individuals trapped at the receding edges of rapidly drying pools.

Ben-Ze'ev and Kenneth (1979) report cystidia but no rhizoids from *Zoophthora erinacea* Ben-Ze'ev & Kenneth, but note the similarity of rhizoids and cystidia of species referable to *Zoophthora* subg. *Erynia* Batko (1966). They muse on the possible inter-relatedness of cystidia and rhizoids as did Thaxter (1888) and Gustafsson (1965). However, Brobyn and Wilding (1977) provide effective evidence that the functions and course of development of these structures are unrelated in species where they both occur together; it must be assumed, then, that rhizoids and cystidia are under completely separate genetic controls.

Empusa caroliniana, with its multinucleate unitunicate spores borne on simple sporophores and lack of cystidia or rhizoids, is once again shown to stand apart from *Erynia* in all major characters except for the shape of its primary spores. The correct generic assignment for this fungus remains problematic, although its spore karyology, sporophore morphology, and mode of spore discharge more closely resemble the species of *Entomophaga* than any other genus recognized by the Batko, Remaudière, or Ben-Ze'ev/Kenneth classifications.

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* *ERYNIA AQUATICA* (Anderson & Ringo ex Anderson & Anagnostakis) Humber, comb. nov., basionym: *Entomophthora aquatica* Anderson & Ringo ex Anderson & Anagnostakis, 1980, Mycotaxon *10*, 350, NON *Entomophthora aquatica* Anderson & Ringo, 1969, J. Invertebr. Pathol. *13*, 386 (which was invalidly published without a designated type). The combination *Erynia aquatica* (Anderson & Ringo) Remaudière & Hennebert, 1980, Mycotaxon *11*, 301, is also invalid according to Article 45 of the International Code of Botanical Nomenclature.

Erynia delpiniana and *Erynia delphacis* may be true exceptions to the usually rhizoidal state of fungi in this genus. Cavara (1899b) is fastidious in his observations of the small, uninucleate, bitunicate primary spores, secondary apores like the primaries, digitately branched sporophores, and very large and occasionally branched cystidia of *E. delpiniana*. However, he never specifically mentions any hyphae affixing the affected flies to the damp piers of a bridge over a small stream. The flies were completely covered under a dense, dirty-white to straw-colored hymenium. This entire hymenial covering was easily broken away from the cadavers during attempts to detach the insects (Cavara 1899b). Except for the apparent absence of rhizoids all characters of this species match the characteristics used by describe *Zoophthora* subg. *Erynia* Batko (1966); all species in this subgenus have rhizoids and prominent cystidia. *Erynia delpiniana* is known only from Cavara's original collections, but it seems likely that examination of this material or any fresh collections would reveal the presence of rhizoids.

Erynia delphacis is a much more important exception to the presence of rhizoids than the other species considered above. This pathogen of leaf- and planthoppers in Asian rice paddies bears a strong morphological resemblance to *E. neoaphidis* Remaudière & Hennebert (= *Entomophthora aphidis* Hoffman sensu Thaxter) from aphids (Shimazu 1976, 1977; Remaudière and Hennebert 1980), but differs notably in the complete lack of rhizoids on any of its hosts, including two artificially infected aphid species, *Aphis gossypii* and *Macrosiphum akebiae* (Shimazu 1977, and personal communication). *Erynia delphacis* produces cystidia both on its host and in culture. Even though Hori (1906) illustrates and describes spherical, yellow-white resting spores 24-28 µm in diameter and containing many fatty granules, no such spores have been found in subsequent collections of this species in Japan, the Philippines, or Indonesia, nor are they formed in culture.

Remaudière and Hennebert (1980) consider the differences of growth *in vitro* between *E. delphacis* and *E. neoaphidis* to be insignificant and regard *E. delphacis* as a *nomen dubium*. However, a comparison of a Japanese strain (Shimazu F32; our RS 134) and several Philippine isolates of *E. delphacis* (RS 458, RS 459, RS 461, RS 478, RS 479) from green leafhoppers, *Nephotettix virescens*, with numerour cultures of *E. neoaphidis* isolated by Insect Pathology Research Unit personnel indicate that *E. delphacis* grows substantially more rapidly on a wider variety of media (nutritionally simple or complex), and sporulates a great deal more prolifically over a longer time than any culture of *E. neoaphidis* we have yet observed. Until more extensive studies can be made comparing these two species, it appears to be preferable to recognize *E. delphacis* as a legitimate species of *Erynia*. It should also be noted that if later studies indicate the synonymy of *E. delphacis* and *E. neoaphidis*, the International Code of Botanical Nomenclature would require that *E. delphacis* (Hori) Humber must be the correct name for the fungus still generally known as *Entomophthora aphidis* Hoffm. (sensu Thaxter).

Much more pertinent information is needed about the morphology of rhizoids than the perfunctory characterization found in many descriptions that rhizoids are merely "present." As noted by King and Humber (1981), complete descriptive information about rhizoids should include their points of emergence, dimensions (particularly thickness), abundance (few or many?), relative spatial distribution (isolated, aggregated into one or more pseudorhizomorphs, or forming a veil?), and the morphology of any terminal holdfast apparatus. Thaxter (1888), Gustafsson (1965), Ben-Ze'ev and Uziel (1979), and Ben-Ze'ev and Kenneth (1981a-b) are exemplary in the clarity of their illustrations and characterizations of rhizoidal morphology. This descriptive information can be useful for detecting dual infections involving rhizoidal and non-rhizoidal species since Brobyn and Wilding (1977) affirm that the morphologies of rhizoids appear to be species specific.

At least three morphological classes of rhizoids can be recognized: Most rhizoidal species have either (1) numerous individual rhizoids which are relatively little differentiated from vegetative and may or may not have any terminal holdfast differentiation, (2) numerous hypha-like rhizoids aggregated into one or more columnar pseudorhizomorphs, or (3) relatively few, thick rhizoids with strongly differentiated (usually discoid) terminal holdfasts. No comprehensive study of the development and morphology of rhizoids or of their taxonomic distribution has yet been undertaken. The thorough studies of Brobyn and Wilding (1977) were limited to a few species affecting aphids. In view of the observations presented here, however, such a comprehensive study would be exceptionally useful.

Rhizoids as a Taxonomic Character

The Batko classification adopted the widely accepted contention of Nowakowski (1883) that the presence of rhizoids is a major generic character. This criterion, superimposed on those of nuclear number in primary spores and the branching of sporophores had effects which have been regarded as unacceptable and have prevented the general acceptance of the Batko classification (Remaudière and Keller 1980; King and Humber 1981). The Remaudière classification, in turn, rejected the significance of the presence of rhizoids. It seem certain, however, that the absence of rhizoids in many genera is significant while their presence in others is an important secondary character.

Regardless of the level (if any) at which one may accept the taxonomic importance of rhizoids, species presenting exceptions to the normal rhizoidal or nonrhizoidal condition of their genus should be examined carefully. The classifications of *Strongwellsea castrans*, *S. magna*, and *E. caroliniana* in *Erynia* and of *E. apiculata*, *E. major*, *E. papillata*, and *E. carpentieri* in *Conidiobolus* are important examples of possible misclassifications pointed out by the lack or possession of rhizoids.

CYSTIDIA

Cystidia (pseudocystidia, paraphyses, or pseudoparaphyses for other authors) are short to long, spear-like to columnar structures of determinate growth that project above the level of the sporogenous hymenium. Until recently, little has been known of their function, but Brobyn and Wilding (1977) convincingly demonstrated that the cystidia of *Erynia neoaphidis* are penetration organs which rupture the host cuticle and aid the subsequent emergence of the sporophores. The emergence of cystidia before the sporophores also has been noted in *E. erinacea* (Kenneth 1977) and *E. ithacensis* (Kramer 1981). It seems likely that cystidia serve to perforate the host cuticle prior to hymenial formation in all species in which they occur; future investigators should be careful to note the order of emergence of cystidia and sporophores.

Remaudière and Keller (1980) indicate that, apart from *Erynia* and (less commonly) *Zoophthora*, the only other genus in which cystidia occur is *Conidiobolus*. Among the 38 species of *Conidiobolus* accepted by Remaudière and Keller, the only ones ever mentioned to form cystidia are *C. obscurus*, *C. thromboides* (= *E. virulenta*), and *E. carpentieri* (as *E. coleopterorum* Petch 1944); as was noted above, the latter species almost certainly belongs in *Erynia* or *Zoophthora* rather than *Conidiobolus*.

The description of *E. virulenta* (= *C. thromboides*; see Latgé et al. 1980) states that "cystidia occur rarely" (Hall and Dunn 1957). However, as explained above for the "rhizoids" of this species, no subsequent treatment of it reports finding either rhizoids or cystidia. The "cystidia" of *C. thromboides* might have been those of another entomophthoralean fungus which produced both rhizoids and cystidia (see Humber et al. 1977). Hall and Dunn (1957) might also have interpreted vegetative or sporogenous hyphae whose indeterminate growth occasionally far exceeds the general level of the hymenium to be cystidia.

Remaudière et al. (1979) report the formation of long cystidia by *C. obscurus* on aphid cadavers placed in a humid environment. I have observed similar growth of long hyphae above the hymenium of aphids affected by *C. thromboides* but always find these structures to be undifferentiated vegetative hyphae which should not be regarded as cystidia by the definition given above.

The listing of *Lamia* (= *Entomophthora*) *culicis* in a chart by Nowakowski (1883) as having cystidia present and rhizoids absent was corrected by Batko (1964c) as being a typographical transposition not corresponding with the Polish text which correctly notes this species to have rhizoids but no cystidia.

The genus most closely related to *Zoophthora* and *Erynia* must be *Strongwellsea*, with its uninucleate and bitunicate primary spores borne on simple rather than branched sporophores (Batko and Weiser 1965; Humber 1976). Remaudière and Keller (1980) consider the lack of rhizoids and cystidia to be insignificant criteria and use this information to explain their submergence of *Strongwellsea* into *Erynia* (see Humber 1981a). In fact, if cystidia function only for cuticular penetration, it is not surprising that *Strongwellsea* species form no cystidia. These fungi produce no hymenial structures outside the host's body. The abdominal hole (the only cuticular rupture caused by the fungus) begins with a point perforation of the pleuron and enlarges progressively. This point initiation of the rupture appears to be involved with the hypertrophic reaction of the host cuticle which leads, in turn, to the extensive lining of the lower portion of the fungal ball by the host's cuticle. It seems clear that some mechanism completely distinct from that of cystidial penetration is involved in the formation by *Strongwellsea* of an abdominal hole (see Humber 1975, 1976).

In view of the above discussion, it is probably correct to say that the only species in which cystidia (as determinate organs for cuticular penetration) occur are those with uninucleate, bitunicate primary spores borne on branched sporophores and classifiable in *Erynia* or (less commonly) *Zoophthora* sensu Remaudière & Hennebert.

Unlike for rhizoids, the presence or absence of cystidia has never been used to separate genera although the Batko classificaiton recognized their value as a supporting character strongly correlated with the occurence of uninucleate, bitunicate primary spores and branched sporophores. As with the other characters discussed here, exceptions to the usual state of the character in a genus should indicate that a close inspection of the correspondences of all characters of the suspect species with those of other species in the genus is in order. The presence of cystidia in *E. coleopterorum* (Petch 1944), a presumptive synonym of *Conidiobolus carpentieri* (Giard) Remaudière & Keller, offers a significant example of this principle.

RESTING SPORES

Zygospores or Azygospores: A Morphological/Cytological Dilemma

I applaud the de-emphasis by Remaudière and Keller (1980) of the distinction between zygospores and azygospores. They note correctly that resting spores are not known (or are not formed) in a series of species, and that the mode of their formation has not been observed in a large proportion of species that do produce resting spores. Both types of development may occur in closely related species or even within a single species (MacLeod and Müller-Kögler 1973; Humber 1976; Remaudière and Keller 1980; King and Humber 1981).

This developmental distinction has been used only twice as a taxonomic character of generic importance. The peculiar mode of conjugation of (amoeboid?) hyphal bodies or gametangia of *Empusa fresenii* Nowakowski 1883 (= *Neozygites aphidis* Witlaczil 1885) and the resultant jet-black, ovoid zygospores formed at the point of conjugation prompted Thaxter (1888) to set this and related species apart in *Empusa* subg. *Triplosporium*. This taxon was later raised to generic status by Batko (1964b), who was apparently unaware of the nomenclatural priority of the generic name *Neozygites* Witlaczil (see Humber et al. 1981). King (1976b) notes that the double-walled resting spores formed by the species of *Conidiobolus* are anisogamous zygospores. Other types of conidioboloid resting spores such as chlamydospores and villose spores are distinguished from zygospores (or azygospores) by their single rather than double wall structures.

Couch (1939) notes that the zygospores of *Conidiobolus* species are formed in the larger of two gametangia (and are almost always produced in the axis of the parental hypha) while those of *Entomophthora* (sensu lato) are produced in lateral buds from the conjugating hyphae or hyphal bodies. Very few species of *Entomophthora* s.l. produce their zygospores in the hyphal axis: *E. virulenta* (= *C. thromboides*), *E. obscura* Hall & Dunn [= *E. ignobilis* Hall & Dunn = *E. thaxteriana* (Petch) Hall & Bell; see below], and *Empusa dipterigena* Thaxter. The former two species are now recognized as species of *Conidiobolus* by Remaudière and Keller (1980). With the apparent exception of *E. dipterigena*, whose zygosporogenesis is illustrated by Gustafsson (1965), the resting spores of other species of *Entomophthora* or its segregated are budded off from the parental hypha or hyphal body.

Zygospores, the bilayered, thick-walled spores derived from a conjugation of two gametangia, have been a well established phenomenon in the Entomophthorales since their first recognition (Brefeld 1973; Nowakowski 1877, 1882, 1883; Thaxter (1888). Nearly every subsequent major discussion of these fungi has referred to zygospores as sexual spores and to azygospores as asexual spores (Schröter 1897; MacLeod 1956, 1963; Gustafsson 1965; Waterhouse 1973).

In general morphological terms, zygosporogenesis may be called a sexual process, in which case azygosporogenesis must be regarded as asexual. However, in their strict sense, the terms *zygospore* and *azygospore* refer only to the mode of development of a thick-walled spore in the Zygomycotina (Fitzpatrick 1930; Bessey 1950; Ainsworth 1961; Snell and Dick 1971; Alexopoulos and Mims 1979).

There is a hazard in thinking of zygospores as sexual and azygospores as asexual: One can be misled easily into performing an act of semantic sleight-of-hand by then expecting that the *genetic* events of a sexual life cycle, karyogamy and meiosis, necessarily occur in a "sexual" zygospores but cannot occur in an "asexual" azygospore. A related terminological confusion can occur when one refers to the resting spore as the sexual spore in the entomophthoralean life cycle as opposed to the forcibly discharged primary (or secondary) spores which are, in every sense, asexual spores.

Nuclear events in entomophthoralean resting spores — reductions in nuclear number, karyogamy, and meiosis — remain completely uninvestigated in all but a few species. This gap in our knowledge reflects a lack of fundamental studies on the life cycles in this group.

Some cytological studies have noted the progressive reductions of nuclear numbers to two or even a single nucleus in fully mature resting spores (Vuillemin 1900a-b; Krenner 1961; Latgé 1976; Couch et al. 1979; D. McCabe and B. Martinell, unpublished). Other investigators using different species have found no obvious change in the nuclear number from the time of formation to the fully mature, dormant state (Olive 1906; Riddle 1906; Goldstein 1929; Humber 1975). If the Entomophthorales follow patterns of karyogamy and meiosis similar to those in other Zygomycetes (Cutter 1942a-b), karyogamy should occur in the resting spore followed by meiosis in the spore just before or during its germination. No conclusive cytological evidence of nuclear fusions or of meiotic division has yet been found in entomophthoralean fungi despite the strong circumstantial evidence for their occurences (*e.g.*, Couch et al. 1979). It must be hoped that synaptonemal complexes, a widely recognized ultrastructural marker for chromosomal synapsis, will be demonstrated at the time and site of the presumptive meiosis in one or more members of the Entomophthorales.

Data regarding changes in nuclear numbers presented by Latgé (1976) support the possibility that karyogamy and meiosis occur in the resting spores of *C. thromboides*, and that the vegetative nuclei of this species must be haploid. Albeit, Latgé feels that his data are also compatible with gametangial meioses of diploid nuclei such as occurs in the Oomycetes (see Alexopoulos and Mims 1979). Little ambiguity about the interpretation of the life cycle remains, however, in view of the results of electrophoretic analyses of isozyme patterns of several strains of *C. thromboides* and *Z. radicans* (May et al. 1979) and of *E. muscae*, *Massospora cicadina* Peck, and *Entomophaga grylli* (Fres.) Batko (Soper, May, and Martinell, in preparation). These results suggest that the vegetative nuclei of these species are haploid, although heterokaryosis may occur in some species since multiple alleles of some loci may be present in a mycelium.

There is no evidence yet of heterothallism within the Entomophthorales. All zygosporogenesis appears to be homothallic and leaves open at least two possible interpretations for the life cycles of these fungi: Those species whose zygospores or azygospores at some point contain only a single nucleus probably have autogamous (sexual) life cycles. Those species whose zygospores or azygospores undergo no reduction in nuclear numbers may have abandoned a sexual life cycle in favor of an apogamous (asexual) life which preserves the particular (successful) combination of characters in that species. No evidence now exists that parasexuality occurs in any species of the Entomophthorales.

The distinction between zygospores and azygospores cannot be retained as a character of taxonomic significance although the presence and nature of zygospores is a useful ancillary character in at least *Triplosporium* and *Conidiobolus*. The developmental origins of resting spores can be difficult to interpret correctly even if suitable material is available. Nuclear events in resting spores are of far greater importance for the fungus than whether conjugations precede sporogenesis. Karyogamy and meiosis, the critical genetic events in a sexual life cycle, apparently may occur in either zygospores or azygospores; similarly, other species may have apogamous life cycles regardless of whether their resting spores are zygospores or azygospores.

Indeed, the full details of entomophthoralean life cycles and their breeding strategies may yet prove to be useful taxonomic characters, but not enough is currently known of these processes to draw meaningful conclusions. There is no doubt, however, that this information is of absolutely vital importance for the practical development and manipulation of these fungi for use in the microbial control of their insect hosts.

Resting Spores: Problems and Interpretation of Taxonomic Traps

It appears that the generic events of sexual reproduction might occur in either zygo- or azygospores, and that even species producing "sexual" zygospores might be apogamous. Several further caveats and an example serve to reinforce the rejection of any taxonomic value which might be attached to the distinction between zygospores and azygospores (Remaudière and Keller 1980).

In most instances, authors simply state their observation that the resting spores of a given species are zygospores or azygospores and neither illustrate nor discuss the evidence supporting this conclusion. However, Sawyer (1931) notes the great difficulty in determining if conjugations occur in *Z. radicans*. Humber (1975) also notes difficulties with the resting spores of *Strongwellsea* species due to problems of interpreting the morphology of some hyphal bodies and to the evanescence of the emptied hyphal wall remnants which provide the only temporary evidence for the mode of formation of mature resting spores;

determining the "pedigree" of these resting spores is dependent upon seeing them during a relatively narrow period during their development. Consequently, it seems unwise to place full confidence in any characterization of resting spores as zygo- or azygospores unless convincing documentation is also presented.

The difficulty in correctly applying these developmental designations casts doubt on whether any taxonomic decisions should be based solely on this distinction (even though it may have some utility for characterizing, but not separating, some genera as noted above). The practical effects of differing viewpoints of the value of this distinction can be seen in the following example:

In studies on the identities of aphid-pathogenic species of the Entomophthorales, Humber (1978) noted that *Entomophthora ignobilis* Hall & Dunn should be used as the nomenclaturally valid name for *Entomophthora thaxteriana* (Petch) Hall & Bell, a species to which Hall and Bell (1963) considered *E. ignobilis* to be identical. *Empusa thaxteriana* Petch (1938) was proposed for a species misidentified by Thaxter (1888), and which was characterized as having azygospores. The resting spores of *E. ignobilis* are described by Hall and Dunn (1957) as zygospores. Humber (1978) considered the reported differences in the origins of resting spores to be so ambiguous as to be insignificant, an opinion which is reinforced here. A later study by Remaudière et al. (1979) used morphological and biochemical data to demonstrate the synonymy of *E. thaxteriana* and *E. obscura* Hall & Dunn (1957) [= *Conidiobolus obscurus* (Hall & Dunn) Rem. & Keller], which was described as producing azygospores.

In fact, the differences between *E. thaxteriana*, *E. ignobilis*, and *E. obscura* had always been troublesome for diagnosticians. The only major described difference between *E. ignobilis* and *E. obscura* is that of zygospores versus azygospores, a difference considered here, by Humber (1978), and by Remaudière and Keller (1980) to be insignificant. A more consistent and simple approach to this taxonomic problem would have been to accept *E. obscura* to be the correct name by virtue of page priority over *E. ignobilis* rather than to regard the latter species as a *nomen dubium* merely because of the described difference in the origins of the resting spores in these two species (Remaudière et al. 1979).

If there is to be even-handed application of the accepted taxonomic criteria and acknowledgement of the net effects of rejecting other criteria which have been applied in the past, it is now necessary to recognize the correct synonymy of *Conidiobolus obscurus* to be the following:

Conidiobolus obscurus (Hall & Dunn) Remaudière & Keller 1980, Mycotaxon *11*, 331.

≡ *Entomophthora obscura* Hall & Dunn 1957, Hilgardia *27*, 162.

≡ *Entomophaga obscura* (Hall & Dunn) Batko 1964, Bull. Acad. Polon. Sci., Sér. Sci. Biol. *12*, 404.

= *Entomophthora ignobilis* Hall & Dunn 1957, Hilgardia *27*, 162.

= *Entomophthora planchoniana* Cornu sensu Thaxter 1888, Mem. Boston Soc. Nat. Hist. *4*, 165, NON sensu Petch 1938, Trans. Brit. Mycol. Soc. *21*, 34.

≡ *Empusa thaxteriana* Petch 1938, Trans. Brit. Mycol. Soc. *21*, 34. NAME INVALID WITHOUT LATIN DIAGNOSIS.

[≡ *Entomophthora thaxteriana* (Petch) Hall & Bell 1963, J. Insect Pathol. *5*, 186.]

[≡ *Entomophaga thaxteriana* (Petch) Batko 1964 Bull. Acad. Polon., Sér. Sci. Biol. *12*, 404.]

CHOOSING A CORRECT CLASSIFICATION: TRIAL BY ANOMALY

One of the most severe tests for a classification system is to see how well it can handle the least typical species from the group being classified. Within the Entomophthorales, several seemingly anomalous generic assignments from both the Batko and Remaudière classifications are discussed here. However, in terms of testing the real capacities of these or any other classifications of these fungi, confirming the correlations of characters, or suggesting where primary taxonomic weights should be placed, the most important fungus has not yet been considered. This is an undescribed species found by Bałazy (1978) in Poland which was, obviously, not known at the time of the proposition of the Batko classification, and was not considered by the Remaudière classification.

This fungus affixes gnats (Diptera: Tendipedidae) by rhizoids to wet, decayed wood just above a stream surface in a deciduous forest in the Wielkopolski National Park, Poland. Its primary spores are slender and curved, 45-75 (82) x 8-10.5 µm, strongly tapered apically and with a flattened, conical papilla. These characters almost exactly match those of *Erynia conica* (Thax.) Rem. & Henn., which has slender curved spores (of a size identical to Bałazy's fungus) with bitunicate walls and single nuclei, borne on branched sporophores, and with cystidia and rhizoids present. Bałazy's fungus is, however, clearly different from *E. conica* since its primary spores have unitunicate walls, contain 4-10 nuclei, and are borne on simple sporophores; cystidia are absent.

The Remaudière classification, with its primary emphasis on spore morphology, would place this species in *Erynia* even though that assignment would be impossible if one accepts the emended circumscription advocated here (excluding *Strongwellsea* and *E. caroliniana* from the genus by limiting it to species with uninucleate, bitunicate spores borne on branched sporophores and not producing capillispores). The Bałazy fungus might be regarded as a species of *Culicicola* except that Batko (1974) apparently rejected *Culicicola* as a heterogeneous mixture of species now regarded to belong to *Entomophthora* s.str. or *Conidiobolus* (Remaudière and Keller 1980; King and Humber 1981). There is no basis for including the Bałazy fungus in *Conidiobolus* according to the circumscriptions of this genus either stated or implied by Batko (1974), Remaudière and Keller (1980), here, or in Humber (1981b). It might be assumed that the Polish fungus could be allied to *E. apiculata*, *E. major*, and *E. papillata* because of their multinucleate unitunicate spores, except that the nuclear morphology of the latter species corresponds to that of *Conidiobolus* species while that of the Polish fungus resembles *Entomophthora* and all of its segregates rather than *Conidiobolus* (see Humber 1981b). The generic system outlined by Ben-Ze'ev and Kenneth (1981a) would include this species in *Entomophthora* sensu stricto, but the mode of spore discharge in the Bałazy fungus is by the eversion of the papilla.

If, as suggested here, one rejects spore morphology as the primary generic criterion and accepts the restriction of *Erynia* noted above, and places generic value upon the karyology of primary spores, the morphology of the sporophore, and the mode of spore discharge, the only remaining sensible disposition for Bałazy's fungus is in a new and (for now) monotypic genus allied to but differing from *Erynia*. It seems reasonable to assume that other entomophthoralean species may yet be found with characters like those of the one characterized by Bałazy (1978).

It is imperative that this Polish fungus be fully characterized and more widely publicized. This fungus seems certain to provoke much useful discussion of the taxonomic criteria which should be accepted for entomophthoralean fungi, and of how much weight should be accorded to each of these criteria.

MODERN VIEWS OF ENTOMOPATHOGENIC GENERA OF THE ENTOMOPHTHORALES

This study has examined the major morphological criteria used in entomophthoralean taxonomy, particularly as they are applied in the generic classification schemes proposed by Batko and by Remaudière and his colleagues. It is apparent from all of the above considerations that the application of only three characters provides an effective separation of species into morphologically and biologically homogeneous genera. These characters are the following:

1. The number and nature of nuclei in the primary spores.
2. The morphology of the sporophores (and the mode of sporogenesis).
3. The mode of discharge of primary spores.

Neither the morphology of primary spores, types of secondary spore formed, presence or absence of rhizoids, presence or absence of cystidia, nor the mode of formation of resting spores was found here to be important for delimiting genera in the Entomophthorales. Each of these characters, however, may have utility as secondary or supporting characters which do not in themselves determine the limits of genera. Some of these characters are appropriate for the circumscription of subgeneric taxa (Ben-Ze'ev and Kenneth 1981a).

It is appropriate to summarize the difference among the Batko and Remaudière classifications and that proposed preliminarily by Ben-Ze'ev and Kenneth (1981a), and to note those adjustments which seem to be necessary to circumscribe these genera still more accurately according to the criteria accepted here.

ENTOMOPHTHORA Fresenius. Batko's overestimation of the importance of rhizoids caused him to split a small and natural group of species (MacLeod et al. 1976; Samson et al. 1979) with simple sporophores, campanulate apiculate primary spores containing a relatively small number of nuclei, and a characteristic mechanism of spore discharge among two genera. The application of the mechanism of spore discharge as a generic criterion confirms the narrow definition of *Entomophthora* proposed by Remaudière and Keller (1980) despite the de-emphasis here of the value of spore morphology. The exceptionally high degree of morphological and biological homogeneity of this group of species would be manifestly lowered if the mode of spore discharge did not exclude both *Empusa caroliniana* Thaxter and the species found by Bałazy (1978) and discussed above. Both of these species have simple sporophores and plurinucleate primary spores but are discharged by papillar eversion rather than by the "fungal cannon" mechanism of *E. muscae*.

MASSOSPORA Peck. This venerable genus which affects gregarious cicadas (Homoptera: Cicadidae) was not treated in the Batko classification until his phylogenetic treatment (Batko 1974) since *Massospora* represents the only genus of the entomogenous Entomophthorales whose validity and circumscription (see Soper 1974, 1981) has never been questioned. The species of this genus have plurinucleate primary spores which are not forcibly discharged from the simple sporophores lining small cavities in the abdomen of affected insects.

TRIPLOSPORIUM (Thaxter) Batko, nom. gen. conserv. prop. Batko (1964b) accepted Thaxter's (1888) belief that *E. fresenii* and similar species should be accorded generic status. This small and natural group of species is distinguished primarily by its unique mode of zygosporogenesis and ovoid zygospores with black (or very dark) epispores. Batko (1964b) circumscribed the genus to include species whose primary spores are quadrinucleate, borne on simple sporophores, and capable of producing capillispores as one type of secondary spore. Remaudière and Keller (1980) accept Batko's circumscription of this genus but they (1) reject the requirement for the primary spores to be quadrinucleate in order to justify the (contentious) inclusion of *E. turbinata* Kenneth (1977), and (2) replace *Triplosporium* (Thaxter) Batko with the older generic name *Neozygites* Witlaczil (1885). Humber et al. (1981) offer several reasons why *Triplosporium* should be conserved against the older and nomenclaturally correct name *Neozygites*; this nomenclatural issue will be resolved at the 13th International Botanical Congress during the summer of 1981.

ENTOMOPHAGA Batko. This genus, based on *Entomophthora grylli* Fres., was proposed to include species wtih multinucleate spores and simple sporophores but without forming rhizoids. Its validity has been questioned because of its linkage to the unacceptable *Culicicola* through Batko's emphasis on rhizoids and also because no satisfactory criterion has been proposed to distinguish unambiguously between any of these species and the morpholgoically similar *Conidiobolus*. The lack of this criterion seemingly prompted Remaudière and Keller (1980) to emphasize spore morphology by transferring all species of *Entomophaga* and those of *Culicicola* with round rather than campanulate priamry spores to *Conidiobolus*. However, the criterion of nuclear morphology noted above and discussed fully by Humber (1981b) readily delimits *Conidiobolus* from *Entomophthora* sensu stricto and its segregate genera, and confirms the validity of *Entomophaga* for species with multinucleate unitunicate primary spores containing large, readily stainable nuclei, and discharged by papillar eversion from simple sporophores.

ZOOPHTHORA Batko and *ERYNIA* Nowakowski. Batko (1964b) described *Zoophthora*, with *Entomophthora radicans* Brefeld (= *Entomophthora sphaerosperma* Fresenius) as its type, for all species having uninucleate, bitunicate spores borne on branched sporophores and producing rhizoids. This genus has been accepted as a natural and valid grouping. Four subgenera were proposed by Batko (1966) based on the morphology of sporophores, rhizoids, and cystidia, and the type of secondary spores produced. Remaudière and Hennebert (1980) limited *Zoophthora* to species capable of forming anadhesive secondary spores atop capillary sporophores (see King and Humber 1981), with all other *Zoophthora* species being transferred to *Erynia* Nowakowski (1881). The Remaudière classification modified the sense of Batko's grouping to accommodate species with simple sporophores and even multinucleate unitunicate primary spores so long as the spore shape was similar to that in other *Erynia* species.

For purposes of discussing the Remaudière classification in this paper, it has been necessary to accept this generic separation on at least a provisional basis. Considerable objection can be raised, as noted above, about the use of capillary sporophores as a character of generic significance. This issue has been treated in part by Ben-Ze'ev and Kenneth (1981a) and will be discussed more fully by these authors in a subsequent paper.

A nomenclatural problem reminiscent of the simultaneous use of *Empusa* Cohn and *Entomophthora* Fresenius as taxonomically distinct genera has been raised by Remaudière and Hennebert's use of both *Zoophthora* Batko and *Erynia* Nowakowski. In 1881, Nowakowski proposed the genus *Erynia* to include *Entomophthora ovispora* Nowakowski (1877) and *Entomophthora curvispora* Nowakowski (1877), but later rejected this generic name in favor of Brefeld's (1877) usage of *Entomophthora* as taxonomically distinct from *Empusa* (Nowakowski 1882, 1883). At the time of its description, *Zoophthora* Batko (1964b) included only its type species, *Entomophthora radicans* Brefeld. However, the inclusion in *Zoophthora* of *E. ovispora* and *E. curvispora* (Batko 1964d) automatically required the adoption of the earlier name. Batko (1966) was incorrect in believing that Nowakowski's later disuse of *Erynia* removed that name from consideration in matters of nomenclatural priority.

The ultimate resolution of this nomenclatural problem with *Erynia* and *Zoophthora* depends on the outcome of the debate to establish a concensus opinion of whether the Batko or Remaudière classification, or some modification of one of them shall be accepted for the species with bitunicate, uninucleate spores on branched sporophores. If, on the one hand, two genera are recognized with one based on *Entomophthora ovispora*, the type species chosen for *Erynia* by Remaudière and Hennebert (1980), and the other on *Entomophthora radicans*, there is no nomenclatural problem to resolve. If, on the other hand, common practice rejects any generic separation and recognizes only a single genus which includes both *E. ovispora* and *E. radicans*, then either *Erynia* would have to be adopted as the correct generic name or *Zoophthora* might be proposed for conservation against *Erynia*.

It is unfortunate that such a confusing nomenclatural issue should arise once more in the Entomophthorales, but the three possible resolutions are unambiguous. My personal opinion should be clear from this paper: I do not believe that the species originally classified by Batko in *Zoophthora* should be split between two genera separated by characters such as spore morphology and the formation of capillary sporophores. As much as it might prevent some amount of further confusion in the literature if *Zoophthora* Batko were conserved against *Erynia* Nowakowski, I do not believe that such a proposal would be accepted for incorporation in the lists of *nomina conservanda* in the International Code of Botanical Nomenclature. The great preponderance of species proposed as or transferred to *Zoophthora* have already been transferred to *Erynia* by Remaudière and Hennebert (1980) or here; the relative number of species required to be transferred as a consequence of conservation of a younger name against an older and nomenclaturally correct one appears to be one of the major concerns of the nomenclatural committees which decide these matters. The new combinations in *Erynia* proposed here are fully justified and nomenclaturally correct whether one accepts the taxonomy of Batko (and his followers) or or Remaudière and Hennebert for classifying the species in question.

STRONGWELLSEA Batko & Weiser emend. Humber. Humber (1976) provided an emended generic description and validation of this genus whose spores are uninucleate and bitunicate but are borne on simple rather than branched sporophores, and are discharged by papillar eversion. Remaudière and Keller (1980) provided no effective rationale for rejecting the importance of sporophore morphology or other diverse supporting data (Humber 1976) in order to synonymize *Strongwellsea* with *Erynia*. There can be little doubt from the criteria considered here to be significant at the generic level that *Strongwellsea* must be recognized as a separate genus. A more extensive support for this opinion is presented by Humber (1981a).

CULICICOLA Nieuwland. This genus is nomenclaturally superfluous since its type species, *Entomophthora culicis* (Braun) Fres., belongs in *Entomophthora* sensu stricto (Remaudière and Keller 1980; King and Humber 1981). The species included in this genus by Batko (1964c-d) are now dispersed to *Entomophthora* s.str. or *Conidiobolus* Brefeld by Remaudière and Keller, although some question remains whether the conidioboloid species producing rhizoids — *E. apiculata*, *E. major*, and *E. papillata* (which was not classified by Batko, 1964d, but clearly belonged in this group) — should be in *Conidiobolus* or in a closely allied but different genus. Batko's inclusion in *Culicicola* of *E. virulenta* (= *C. thromboides*; see Latgé et al. 1980) was based on the erroneous description of this species as producing rhizoids (Humber et al. 1977).

Batko regarded this as the most tentative of his proposed segregate genera, and he later apparently rejected *Culicicola* in his extended justification of his taxonomic ideas and discussion of phylogeny in the Entomophthorales (Batko 1974). *Culicicola* has been the most objectionable of his genera for other students of these fungi.

CONIDIOBOLUS Brefeld. Even though Batko and Weiser (1965) note that resting spores of *Conidiobolus* are not budded off to the side as in all other genera considered in the Batko classification, they again cited the widely used but untenable "criterion" which supposes *Conidiobolus* species to be basically saprobes while those of the other genera treated were entomopathogenic. Remaudière and Keller (1980) regard the lack of a suitable criterion to delimit *Conidiobolus* from morphologically similar species put in *Culicicola* and *Entomophaga* by Batko (1964b-d), with round to pyriform, multinucleate primary spores and simple spores, to justify their inclusion in a broadly redefined *Conidiobolus*.

As indicated here, however, nuclear cytology does provide the criterion sought to delimit *Conidiobolus* species from those of *Entomophthora* and its segregates (Humber 1981b). Some of the species transferred to *Conidiobolus* from *Entomophthora* sensu lato truly are species of *Conidiobolus*; these include *E. virulenta* (= *C. thromboides*; Latgé et al. 1980), *C. obscurus*, and possibly *C. apiculatus*, *C. major*, and *C. papillatus* (although these last three species may belong in a separate genus allied to *Conidiobolus* due to marked differences in the structure of the sporophore with the presence of rhizoids as a supporting character). Other species — *e.g.*, *E. grylli*, *E. batkoi*, and *E. gigantea* Keller — have nuclei whose morphology indicates their closer affinities to *Entomophthora* than to *Conidiobolus* (Humber 1981b).

TABANOMYCES Couch, Andreeva, Laird, & Nolan. This little known genus (Couch et al. 1979) was described for the peculiar mode of germination and spore formation from entomophthoralean resting spores found in larvae of tabanid flies in the Soviet Union. The thick-walled, colorless, ovoid resting spores of the type species, *T. milkoi* (Dudka & Koval) Couch & al., were originally described as *Coelomomyces milkoi* Dudka & Koval. During the germination of the spores, the single nucleus undergoes two (meiotic?) divisions, and a short, thick, quadrinucleate sporophore forms. This hypha becomes septate, and each uninucleate cell produces and discharges a lateral primary spore which is, in turn, capable of producing a secondary spore on a short capillary sporophore (Couch et al. 1979). These events and structures are essentially identical to those described for the germination of resting spores in the nematophagous genus *Meristacrum* Drechsler (Davidson and Barron 1973). The nuclei illustrated by Couch et al. (1979) are relatively small and have a prominent central nucleolus; this type of nucleus resembles that of *Conidiobolus* (Humber 1981b) and *Meristacrum* (Humber, unpublished).

Remaudière and Keller (1980) do not mention *Tabanomyces*, but this genus cannot be easily placed in any entomogenous genus included in the Batko or Remaudière classifications. The remarkable similarity of *Tabanomyces* and *Meristacrum* indicates that these genera are synonymous and that *T. milkoi* must be recognized as a heretofore unknown entomopathogenic species of *Meristacrum**.

TARICHIUM Cohn. This genus was created for those species of the Entomophthorales known only by their resting spores (see MacLeod and Müller-Kögler 1970). Neither the

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* *MERISTACRUM MILKOI* (Dudka & Koval) Humber, comb. nov., basionym: *Coelomomyces milkoi* Dudka & Koval in Dudka, Koval & Andreeva, 1973, *Novitates Systematicae Plantarum non Vascularium 10*, 88-91. SYNONYM: *Tabanomyces milkoi* (Dudka & Koval) Couch, Andreeva, Laird & Nolan, 1979, Proc. Natl. Acad. Sci. (USA) *76*, 2299-2302.

Batko nor Remaudière classifications fully accept this genus, but properly regard its members as having still undetermined affinities. It can be assumed that *Tarichium* species may be connected to a species producing primary spores and, thus, placed in the appropriate modern genera. A taxonomic system which accepts a narrow sense of *Entomophthora* and a number of other entomopathogenic segregate genera must also accept *Tarichium* as the correct provisional generic name for the species involved rather than the name *Entomophthora (Tarichium)* as was suggested (without any formal nomenclatural status as a subgenus of *Entomophthora*) by MacLeod and Müller-Kögler (1970).

Concluding Remarks on Generic Classifications

Despite its manifest shortcomings, the classification proposed by Batko (1964a-e, 1966; Batko and Weiser 1965) forms the basis for all other contemporary approaches to a generic classification for the Entomophthorales. This classification is discussed in depth (although not substantially amplified) in the first attempt to outline the course of evolution in the Entomophthorales (Batko 1974). The Remaudière classification attempted to eliminate the flaws which Remaudière and his colleagues perceived to prevent the general acceptance of the Batko classification. A generic arrangement more similar to that proposed by Batko than by Remaudière, Hennebert, and Keller emerges here in view of the acceptance of primary spore karyology, sporophore morphology, and the mode of primary spore discharge as the three characters best suited for delimiting genera. Ben-Ze'ev and Kenneth (1981a, 1981b, and other papers in preparation) also accept the karyology of primary spores and morphology of sporophores as characters with generic importance, but do not recognize the mechanism of spore discharge to be taxonomically significant.

No formal proposal of yet another new generic classification seems appropriate at this time. This study has sought only to evaluate the characters and criteria which have been or might be used to construct generic classifications of the Entomophthorales. I have extended the conclusions of this study regarding appropriate generic criteria to the existing classification schemes in order to show their net effects and to stimulate further discussion and debate.

Each attempt to propose a new generic classification for the Entomophthorales has suffered from the effects of one or more faultily circumscribed genera and from the less obvious effects of incompleteness. It is clear from the still incomplete catalogue of species described as or attributable to *Entomophthora* (sensu lato) (MacLeod 1963; MacLeod and Müller-Kögler 1970, 1973; MacLeod et al. 1976), that the available information about a distressing number of species is inadequate to allow a reliable classification in the narrowly defined genera comprising the contemporary classification schemes. I must also be noted that all of these latter-day efforts to reclassify the Entomophthorales have concentrated almost exclusively upon the entomopathogenic genera. Several morphologically diverse genera are known only as saprobes or pathogens of fern gametophytes, desmide algae, tardigrades, and nematodes; at least three species of this order are also known to affect humans and other vertebrates (King 1979). These fungi are no less valid members of the Entomophthorales than those species attacking insects; it is inappropriate to argue about the choice of criteria used to define genera or about the correctness of one or another classification of the Entomophthorales without taking these non-entomogenous genera into full account.

Despite these impediments to the proposition of a comprehensive generic scheme, however, I believe that most concerned parties now agree that following a period of further discussion of taxonomic criteria, it will be possible to propose a generally acceptable, realistic, and phylogenetically based classification for the Entomophthorales in which each genus will have a uniformly high degree of morphological and biological homogeneity. Despite the obvious difficulties in proposing such a comprehensive scheme, some comfort should be found in the thought that IF the generic scheme which is yet to emerge is accurate, then no further major adjustments of generic circumscriptions should be necessary. As new taxa are found and described, and as older taxa being held in abeyance become better known, they will be classified in the existing stable generic structure or seen to differ in enough significant characters to warrant the erection of new genera.

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LES HYMENOCHAETE A ELEMENTS HYMENIENS PINNATIFIDES

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SUMMARY

Hymenochaete acanthophysata nov.sp. with acanthophysate hyphae and *Hymenochaete hauerslevii* nov.sp. with pseudoacanthophyses are described. The author compares these African species with the only two known species with pinnatifid-tipped hyphidia in their hymenium: *H. digitata* Burt and *H. pinnatifida* Burt. The later has been found again: descriptions of a non stratose specimen from Africa and of a two-layered specimen from Guadalupe are given. An abstract in English including a detailed key to species is given in the end of the paper.

INTRODUCTION

Dans le cadre d'une étude des spécimens du genre *Hymenochaete* récoltés principalement en Afrique par J. BOIDIN d'une part et G. GILLES d'autre part, nous avons décrit précédemment une espèce, *H. spathulata,* remarquable par ses spinules à sommet spatulé (LEGER, 1980) ainsi que deux espèces, *H. separabilis* et *H. harpago* (LEGER, 1981) à spinules pourvues de diverticules.

Le présent travail a trait aux espèces dont l'hyménium possède des éléments stériles ornés de digitations. Jusqu'ici deux espèces présentent ce caractère: *H. pinnatifida* Burt et *H. digitata* Burt. *H. pinnatifida* a été retrouvé en République Centrafricaine, au Gabon et à la Guadeloupe. Une description complète est donnée qui fait apparaître notamment que cette espèce peut être bistratifiée. A titre comparatif, l'étude de *H. digitata* est reprise et complétée à partir du type de BURT. Enfin, deux espèces sont décrites : *H. acanthophysata* nov.sp. à hyphes acanthophysoides et *H. hauerslevii* nov.sp. à éléments hyméniens de type pseudoacanthophyses.

HYMENOCHAETE PINNATIFIDA Burt

Ann. Missouri Bot. Gard. 5 : 355. 1918

Basidiome résupiné, étalé, adhérent, mince, 60-150-(200) µm, en petites taches plus ou moins confluentes, brun jaunâtre (Munsell 10YR 5/4 ou encore Saccardo's umber selon Ridgway) puis brun rouillé (Munsell 5YR 4/6) quand il s'étale plus largement, à marge fibrilleuse appliquée, 0,5 mm, chamois (Munsell 10YR 7/8).

Cortex (Cx, fig.1) épais de 5 à 15 µm, sombre, formé d'un enchevêtrement serré d'hyphes brun-rouge foncé, plus ou moins cimentées et collapsées, x 2-2,5-(3) µm, à paroi épaisse.

Contexte (C, fig.1) assez lâche, 50 à 100 µm d'épaisseur, dimitique. Hyphes génératrices hyalines, x 1,5-2 µm, à paroi mince, ramifiées et cloisonnées. Hyphes squelettiques brun-jaunâtre, x 2-2,5 µm, à paroi épaisse, non cloisonnées, exceptionnellement ramifiées.

Spinules brun foncé, la plupart 15-30 x 3,5-5 µm, non émergentes; certaines, plus rares, mesurent 40-50 x 6-7 µm et émergent jusqu'à 20 µm. Toutes ces spinules naissent d'une couche sous-hyméniale sombre.

Hyménium (H, fig.1) de 15 à 20 µm; rares basidioles et très rares basides mûres, 15 x 3 µm, à 4 stérigmates de 3 µm. Dendrophyses jaunes très abondantes, longues de 12 à 22 µm et de diamètre variant de 2 à 6 µm, à nombreuses ramifications très étroites (0,25 µm) en petites touffes terminales pour la plupart. Très rares hyphes paraphysoides grêles grimpant le long de certaines grandes spinules. Assez nombreuses masses cristallines volumineuses (souvent de 10-20 x 10 µm) à la base de l'hyménium.

Sous-hyménium (sH, fig.1) formant une zone sombre de 20 µm environ, d'aspect identique au cortex, constituée d'hyphes plus ou moins cimentées et collapsées, x 2-3 µm, à paroi épaisse.

Spores (sur sporée) cylindriques étroites, très légèrement déprimées, 3,8-4,5-(5) x 1,6-2 µm, hyalines, uninucléées (Giemsa), non amyloides, blanches en masse.

Description effectuée à partir de la récolte LY 5584, La Maboké, République Centrafricaine, 31 mars 1965, leg. J. Boidin (Herb. Boidin).

AUTRES RECOLTES :

LY 5931 sur *Carapa procera*, La Maboké, République Centrafricaine, 16 septembre 1967, leg. J. Boidin.

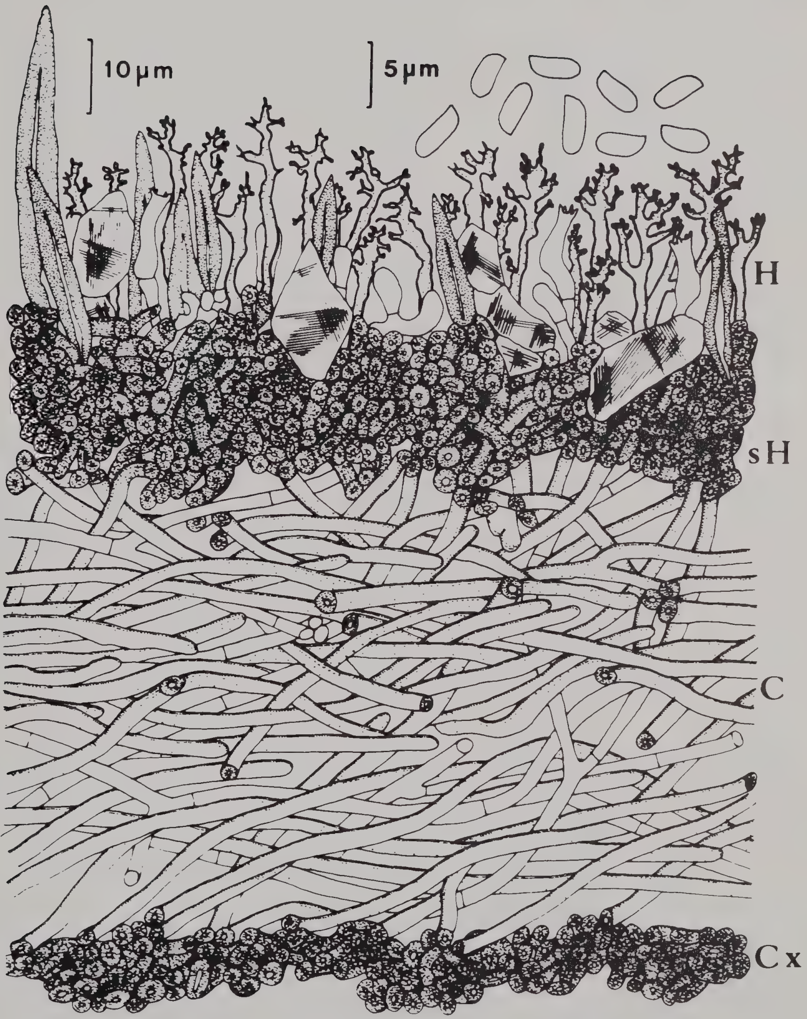
10µm
5µm
H
sH
C
Cx

Figure 1 : Hymenochaete pinnatifida Burt
(LY 5584)

LY 6041 sur support indéterminé, Boubakiti, République Centrafricaine, 27 septembre 1967, leg. J. Boidin.

LY 9260 sur support indéterminé, Libreville, Gabon, 20 novembre 1978, leg. G. Gilles.

ESPECES DE REFERENCES EXAMINEES :

H. pinnatifida Burt, New Smyrna, Florida, january 1897, C.G. Lloyd 2139 (Type) et 2140. (FH).

H. pinnatifida Burt, *ad ligna emortua angiospermae in paroecia Aurelia,* Algiers, 17 september 1971, leg. M.T. Dunn, det. A.L. Welden (*Fungi Ludoviciani ex herbario* Tulane 7655). LY 6723.

LE CAS PARTICULIER DE LA RECOLTE LY 8091 :

Ce spécimen, trouvé par J. BOIDIN le 29 septembre 1976 à la Guadeloupe se présente comme un *H. pinnatifida* bistratifié (fig.2).

Tout se passe comme si un deuxième basidiome complet avec un cortex Cx2, un contexte C2, une zone sous-hyméniale sH2 et un hyménium H2 (pratiquement stérile) etait né d'un basidiome précédent constitué (comme décrit pour LY 5584) d'un hyménium H1, d'un sous-hyménium sH1, d'un contexte C1 et d'un cortex basal Cx1. Dans le dessin de la figure 2, la base du champignon - c'est-à-dire le cortex Cx1 ainsi que les 4/5 du contexte C1 - n'est pas représentée. Le basidiome a une épaisseur totale de 150 à 230 µm dont 100 µm pour le contexte C1 (alors que le contexte C2 n'a qu'une quinzaine de µm d'épaisseur).

DISCUSSION :

Les spécimens africains présentent une très bonne concordance avec le type d' *H. pinnatifida* Burt examiné ainsi qu' avec la récolte américaine LY 6723 déterminée par A.L. WELDEN. Cependant, deux remarques s'imposent :

- L'assez grande variabilité de couleur des basidiomes, non seulement d'une récolte à l'autre mais aussi à l'intérieur d'une même récolte. Nous distinguons trois groupes selon la couleur: gris rosâtre (light cinnamon drab, vers 2,5 YR 6/2) pour LY 9260 et pour le centre de quelques taches de LY 6723; brun rougeâtre (reddish brown, vers 5YR 5/3 à 4/4 ou 4/6) pour LY 6041, LY 8091, LY 6723 *pro parte* et LY 5584 *pro parte*; brun jaunâtre (yellowish brown, vers 10YR 5/4) pour LY 5584 *pro parte* (petites taches très jeunes) et LY 5931. Cette couleur variable s'explique au moins en partie par le développement relatif de l'hyménium: ainsi, les taches de LY 6723 où l'hyménium est bien développé et fertile sont gris rosâtre alors que les taches brun rougeâtre ne présen-

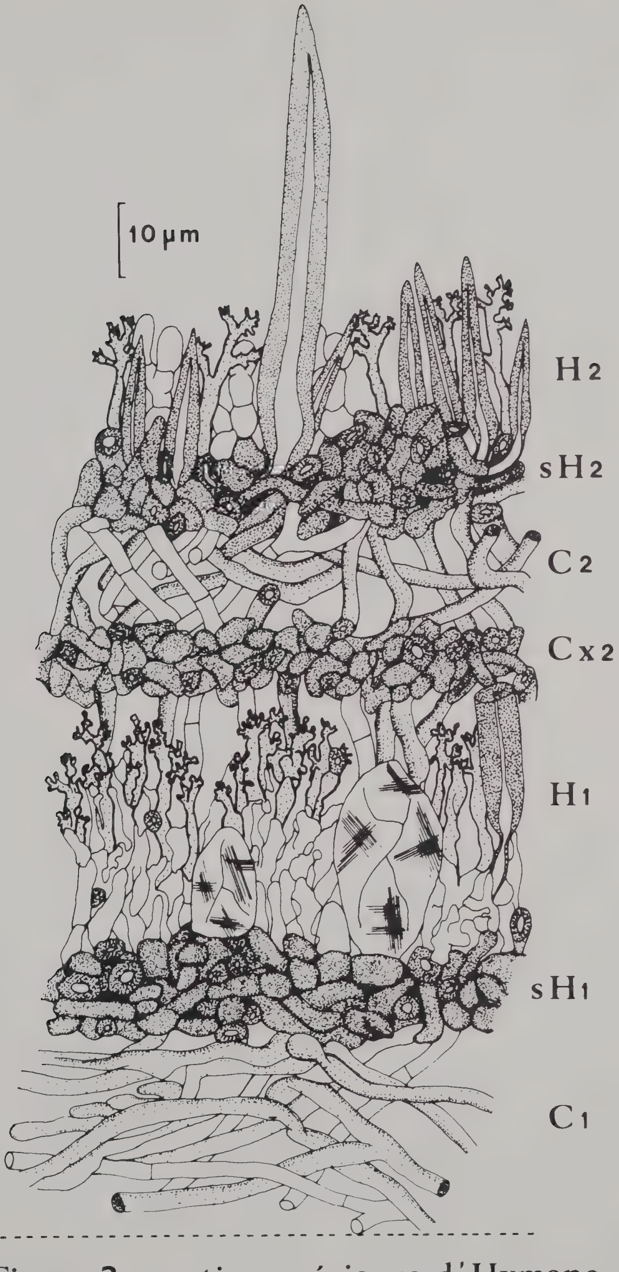
10 µm
H2
sH2
C2
Cx2
H1
sH1
C1

Figure 2 : partie supérieure d'Hymenochaete pinnatifida Burt (LY 8091)

-tent qu'un hyménium faiblement développé, pratiquement stérile et constitué presque exclusivement de dendrophyses. De même LY 9260, dont l'hyménium fertile est bien développé est uniformément gris rosâtre. La marge, chamois à rouillé, a presque toujours une couleur plus vive que le reste de l'hyménium.

- Concernant la stratification, l'examen de la récolte LY 8091 conduit incontestablement à *H. pinnatifida* Burt. Cette bistratification n'a jamais été signalée ni par E.A. BURT, ni ultérieurement lors d'autres récoltes.

En résumé, *H. pinnatifida* Burt est une espèce bien caractérisée par ses dendrophyses (à nombreuses et fines ramifications)issues d'une zone sous-hyméniale sombre, par un contexte dimitique assez lâche et un cortex basal sombre. La couleur de l'hyménium peut varier de façon sensible suivant l'état de maturité tandis que la marge est toujours de couplus vive.

L'aire de dispersion de *H. pinnatifida* s'étend non seulement à l'Afrique mais également à la Guadeloupe dont le spécimen montre un caractère jamais observé jusqu'ici pour cette espèce: une bistratification nette. Il serait intéressant de rechercher aux Etats-Unis notamment, une présence éventuelle de stratification lors de futures récoltes.

HYMENOCHAETE DIGITATA Burt

Ann. Missouri Bot. Gard. 5 : 347 . 1918

Basidiome résupiné, largement étalé, adhérent, épais de 700 à 800 µm, brun havane (Brussels brown à antique brown, 7,5YR 4/4 à 5/6), à surface granulée-tuberculée, à marge très mince, évanescente, concolore.

Cortex (Cx1, fig.4) d'une quinzaine de µm, formé d'un enchevêtrement serré et brun rouge sombre d'hyphes de 2,5-3 µm de diamètre, plus ou moins cimentées et collapsées, à paroi épaisse.

Ce cortex se prolonge par un feutrage assez lâche constituant le revêtement piléique (tomentum T), d'environ 40 µm d'épaisseur.

Contexte (fig. 3 et 4) stratifié, composé d'une alternance d'une quinzaine de couches sombres avec un nombre égal de couches plus claires. Les couches sombres (appelées Cx2 à Cx8 et dont seules Cx7 et Cx8 sont représentées sur la figure 3) ont une teinte brun rouge foncé et présentent une constitution identique à celle du cortex basal Cx1. Les couches plus claires ont une double constitution: d'une part, les

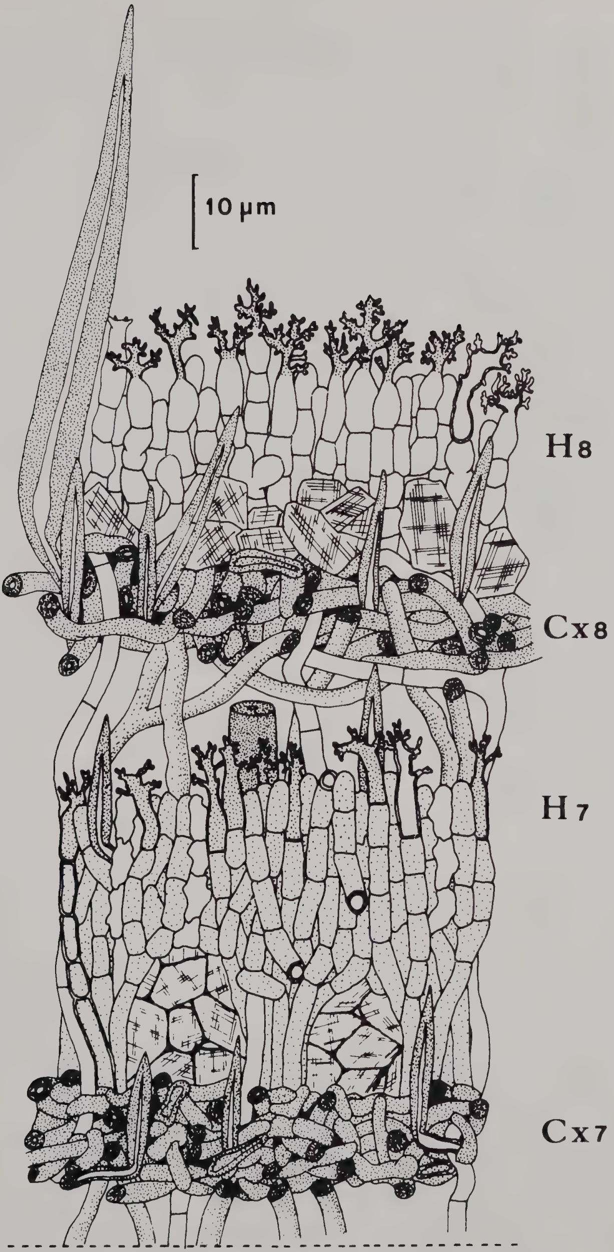
10 µm
H8
Cx8
H7
Cx7

Figure 3 : partie supérieure d'
Hymenochaete digitata Burt (Type)

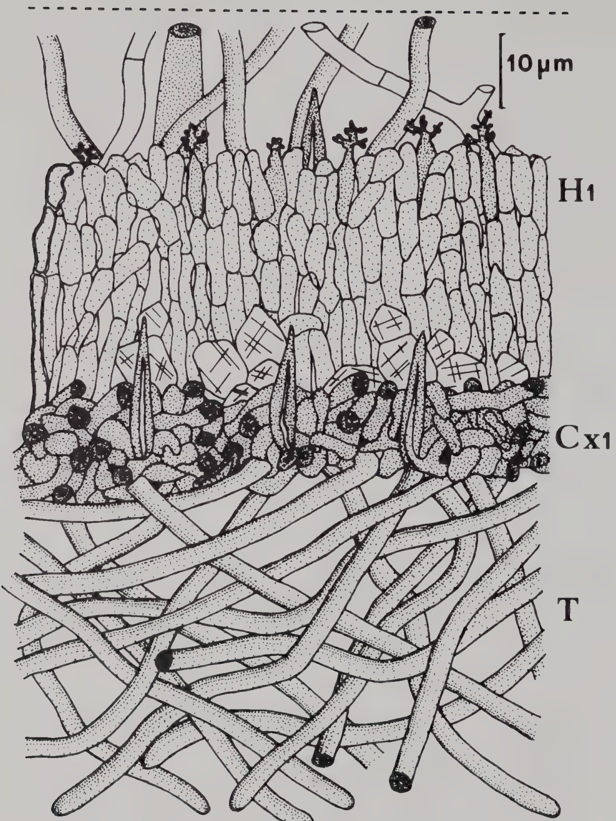

Figure 4: base d'Hymenochaete digitata Burt (Type)

hyméniums antérieurs (nommés H1 à H7 et dont seuls H1,H7,H8 sont représentés sur les figures 3 et 4) sont bruns, formés d'une dense palissade d'hyphes de 2-3 µm de diamètre, à paroi épaissie, à articles relativement courts (7 à 10 µm), très collapsées, auxquelles se mêlent des dendrophyses à paroi épaissie, entièrement jaunâtres. D'autre part, au dessus de chaque hyménium, des zones très claires sont formées d'un enchevêtrement très lâche d'hyphes cloisonnées et ramifiées, de 2-3 µm de diamètre, à paroi mince et d'hyphes non cloisonnées, 2-3 µm de diamètre, à paroi épaissie (dimitisme). A la base de chaque hyménium, de nombreuses masses cristallines plus ou moins volumineuses.

Spinules nées pour la plupart des couches très sombres; elles sont de deux types: très nombreuses petites spinules 20-30 x 2-3 µm, non émergentes et grandes spinules 50-75 x 6-7 µm, moins abondantes et émergentes jusqu'à 40 µm.

Hyménium (H8, fig.3) de 25 µm environ; quelques basidioles mais basides extrêmement rares (non vues par BURT), 13 x 2,5-3 µm, à 4 petits stérigmates de 1,5 µm. L'essentiel est constitué par des sortes de pseudoacanthophyses nombreuses: ce sont des éléments hauts de 12 à 17 µm, à base renflée (3,5-4,5 µm) hyaline et à paroi mince, tandis que l'extrêmité rétrécie, jaunâtre et à paroi épaisse porte de nombreuses ramifications en tous sens. Certaines sont cependant déjà entièrement jaunâtres et à paroi épaissie comme celles des hyméniums antérieurs.

Spores non observées.

Description d'après le type de *H. digitata* Burt, El Boquete, Chiriqui, Panama, W.R. Maxon, 5559. (FH).

DISCUSSION :

L'étude du type de BURT a permis d'apporter quelques précisions sur cette espèce qui n'a pas fait l'objet,depuis le travail originel, d'étude détaillée. Le point le plus intéressant, outre la présence non encore signalée d'un tomentum et la constitution précise des différentes couches de stratification, est sans doute l'aspect détaillé des pseudoacanthophyses qui n'avaient été que superficiellement décrites par BURT.

HYMENOCHAETE ACANTHOPHYSATA Léger nov.sp.

Basidioma resupinatum, late jacens, adherens, tenue, obscure brunneum, magis in medio propter pruinam griseolum; ambitu ex rubiginoso fulvo, margine angustissimo, albo; trama bistrata, dimitica, hyphis genetricibus hyalinis, tunica tenui, x 2-3 µm, ramosis fibulatisque, ex hyphis skeletticis e flavis brunneis, tunica crassa, x 2-3 µm, neque ramosis neque septatis constante; cortice nullo; spinulis brunneis, amplis, 40-70 x 7-8,5 µm, usque ad 35 µm emergentibus; hyphis paraphysoideis gracilibus, x 1-1,5 µm, quasdam spinulas circumdantibus; basidiis rarissimis, 12 x 3 µm, 4 sterigmatis 3 µm longis; permultis hyphis acanthophysoideis, tunica crassa, x 2-2,5 µm, non vel vix emergentibus; passim crystallis inter hymenium praesentibus; sporis cylindratis, leviter depressis, 4-4,5-(5) x 1,5-1,8 µm, hyalinis, uninucleatis, haud amyloideis, in massa albis.

Holotypus : Lyon (LY), leg. J. Boidin n° LY 7741. *In substrato incognito*, Makokou, Gabon.

Ethymologie : espèce ainsi nommée du fait qu'elle possède de nombreuses hyphes acanthophysoides (acanthophyses définies par A. PILAT en 1926).

DESCRIPTION DU TYPE :

Basidiome résupiné, largement étalé, adhérent, mince, 125 à 200 µm, brun sombre (5YR 4/2, *fuligineus* de Saccardo) puis plus grisâtre au centre par la pruine (5YR 5/2, benzo brown R. à 2,5YR 5/2, cinnamon drab R.). Bordure fauve rouillé (7,5YR 5 à 6/6, vers antique brown R.). Marge très étroite, fibrilleuse, très appliquée, blanche.

Contexte (fig.5) bistratifié, dimitique. Hyphes génératrices hyalines, à paroi mince, 2-3 µm de diamètre, ramifiées et cloisonnées. Hyphes squelettiques brun jaunâtre, à paroi épaisse, 2-3 µm de diamètre, ni ramifiées ni cloisonnées.

A la base du champignon (pas de cortex), le contexte est enchevêtré peu sombre (30-50 µm) puis passe à une zone sous-hyméniale plus obscure (8-15 µm) où les hyphes sont plus fermement enchevêtrées et plus ou moins cimentées. Enfin, les hyphes se redressent pour donner l'hyménium supérieur.

Spinules brunes, massives, à extrêmité peu pointue mais assez souvent mucronée, 40-70 x 7-8,5 µm, émergentes jusqu'à 35 µm. Des hyphes paraphysoides grêles (1-1,5 µm) peuvent les entourer.

Hyménium : l'ancien, collapsé, comprend des basidioles fripées, longues de 6-10 µm, des spinules et des éléments acanthophysoides brun jaunâtre. Ces éléments naissent de la zone sous-hyméniale sombre. L'hyménium supérieur est formé de basidioles de 6 à 10 (15) µm de haut, de spinules, de très rares basides 12 x 3 µm, à 4 stérigmates de 3 µm et surtout d'abondantes hyphes acanthophysoides à paroi épaissie, de 2 à 2,5 µm de diamètre, non ou peu émergentes (10 µm). Ces sortes d'acanthophyses à paroi mince lorsqu'elles sont jeunes, naissent d'hyphes squelettiques ou génératrices. Localement, des masses cristallines se rencontrent au niveau de l'hyménium.

Spores (sur sporée) cylindriques, légèrement déprimées 4-4,5-(5) x 1,5-1,8 µm, hyalines, uninucléées (Giemsa), non amyloides, blanches en masse.

Sur support indéterminé, Makokou, Gabon, 5 mai 1976, leg. J. Boidin. Holotype : LY 7741 (Herb. Boidin).

AUTRES RECOLTES :

Côte d'Ivoire : LY 7053, sur support indéterminé, Abidjan, 5 novembre 1972, leg. G. Gilles.

Gabon : Makokou (leg. J. Boidin), sur support indéterminé : LY 7734, 4 mai 1976; LY 7750 et LY 7755, 5 mai 1976; sur

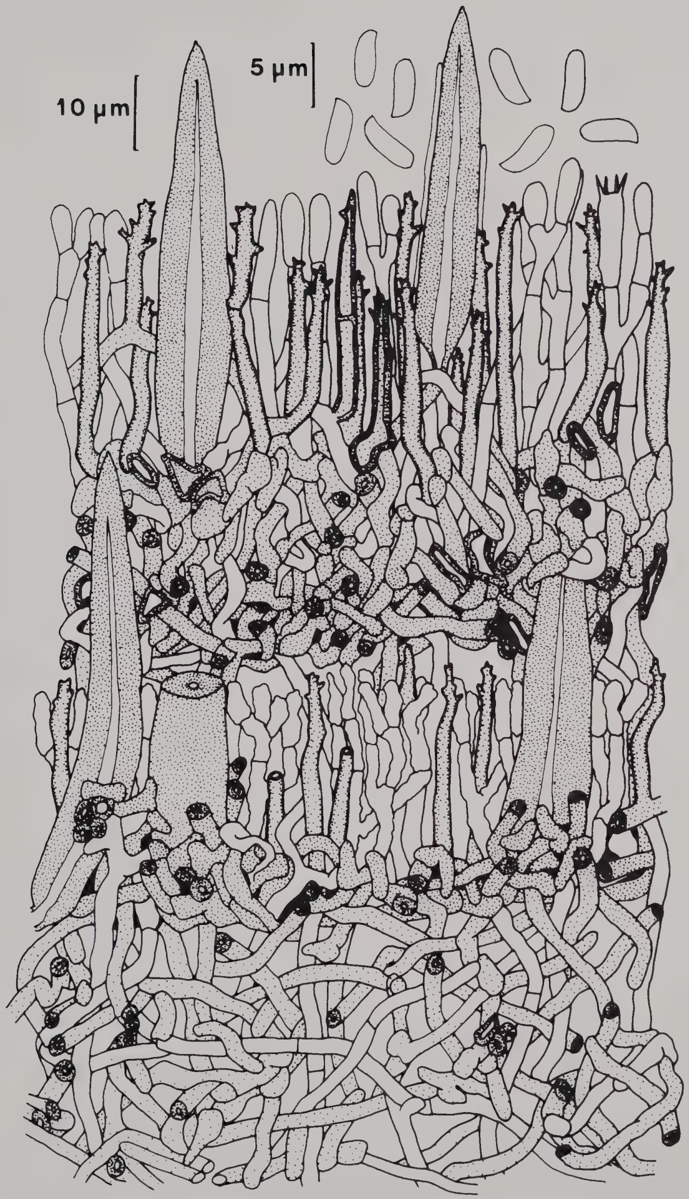

Figure 5 : Hymenochaete acanthophysata

Klainedoxa gabonensis : LY 7759, 7 mai 1976; sur *Ancistrophyllum sp.* : LY 7830, 13 mai 1976.

Gabon : Libreville (leg. G. Gilles), sur support indéterminé: LY 9114, 12 janvier 1979; LY 9151, 4 février 1979; LY 9198, 4 mars 1979; LY 9215, 12 mars 1979; LY 9258, 26 novembre 1978; LY 9261, 10 novembre 1978; LY 9273, 8 avril 1979; LY 9298, 22 avril 1979; LY 9310, 28 avril 1979 et LY 9417, 4 juin 1979.

DISCUSSION :

Ces nombreuses récoltes permettent de mieux cerner les caractères de *H. acanthophysata*, à travers les variations de la couleur de l'hyménium et surtout de la stratification ou non des échantillons :

Couleur de l'hyménium: l'abondance des hyphes acanthophysoides, lorsque l'hyménium n'est que très peu ou pas fertile, provoque un net assombrissement de la couleur. Ainsi, LY 7053, LY 7830 et LY 9417 par exemple qui sont à peu près stériles ont une couleur brun rougeâtre foncé (5YR 4/3 à 3/3 et même 2,5YR 2/4 pour LY 9298); cette couleur est renforcée par un aspect velouté souvent très marqué. Lorsque l'hyménium est bien développé par contre, la couleur est plus pâle: soit plus grisâtre (2,5YR 5/2 à 4/2, naval brown R. pour LY 9261 par exemple) soit plus jaunâtre (7,5YR 5 à 6/4, wood brown R. pour LY 7755). Une même récolte montre assez souvent une telle variation de couleur: par exemple, LY 7750 est tantôt chocolat (5YR 3/4) et velouté, tantôt gris rosâtre (5YR 5/2, benzo brown R.) et aride. De façon similaire, LY 7755 (ainsi que 7759) offre un très bel exemple: le centre est en effet gris légèrement rosé (5YR 6/2) alors que le reste de la surface est bai ferrugineux (5YR 4/6).

Stratification: sur un total de 17 récoltes, seules 5 présentent une stratification: LY 7734, LY 9258 et LY 7741 (type) sont bistratifiés. LY 9273 a quelques strates mais seul LY 7750 (dont l'épaisseur atteint 700 µm) montre 6 à 7 hyméniums successifs. Tous les autres spécimens (épais de 30 à 100 µm) n'offrent aucune stratification. Le basidiome a dans ce cas une structure plus simple: à la base, un mince contexte assez sombre (15-20 µm) formé d'hyphes enchevêtrées en tous sens donne naissance à un contexte vertical dont les hyphes se terminent presque toutes en éléments acanthophysoides; ceux-ci, comme les spinules, sont répartis dans toute l'épaisseur du basidiome. Qu'il s'agisse de spécimens stratifiés ou non, la plupart des récoltes sont presque ou totalement stériles: plusieurs sporées n'ont pu être obtenues et les autres n'ont que peu de spores.

En conclusion, *H. acanthophysata* nov.sp. est une espèce stratifiée ou non, dont le basidiome étalé-adhérent est de couleur brun foncé, parfois velouté, à l'état substérile et plus grisâtre et aride lorsque l'hyménium est normalement constitué (les basides étant de toute façon très dispersées). La présence de nombreuses hyphes acanthophysoides est sans conteste le point le plus remarquable avec les spinules trapues et massives.

HYMENOCHAETE HAUERSLEVII Léger nov.sp.

Basidioma resupinatum, primum tenuissimum, e luteo ochraceo, dein paulo crassius, cinnamomeum, frustulosum, laxe ad subiculum e badio ferruginosum adnatum; ambitu indeterminato, concolore; trama laxe intermixta, ex hyphis brunneis, tunica incrassata, x 4-5-(6) µm, septatis ramosisque constante, atque ex hyphis hyalinis, tunica tenui, x 2-3 µm, septatis ramosisque; cortice nullo; crystallis permultis ad et inter hyphas; spinulis brunneis, acutis, longis angustisque, 90-170-(190) x (4)-6-8 µm, usque ad 100 µm emergentibus; hyphis paraphysoideis gracilibus, x 2 µm, spinulas scandentibus; basidiis saepius paulum constrictis, 12-17-(19) x 4-5 µm, 4 sterigmatis 5 µm longis; pseudoacanthophysibus tunica tenui vel leviter incrassata, non vel vix emergentibus, 10-13-(20) x 3-5 µm, paucis apicalibus diverticulis 2-3 µm longis praeditis; sporis cylindratis (6)-6,5-7,5-(8) x 2,8-3-(3,2) µm, apiculo saepe manifesto, hyalinis, haud amyloideis.

Holotypus : Copenhague (C), leg. K. Bjørnekaer n° Afr.22, *in substrato incognito, in monte* Kenya, Kenya, 31-III-1963.

Ethymologie: espèce dédiée au Dr. K. HAUERSLEV qui nous a signalé et communiqué le spécimen.

DESCRIPTION DU TYPE :

Basidiome résupiné, étalé, d'abord très mince (60 µm), ocre jaune (10YR 6/6, brownish yellow) puis un peu plus épais (100-110 µm), cannelle (7,5YR 6/7, cinnamon), frustuleux, laissant apparaître un feutrage bai ferrugineux (5YR 4/6, reddish brown). Marge indéterminée, concolore.

Contexte (fig.6) lâchement enchevêtré d'hyphes brunes à paroi épaisse, 4-5-(6) µm de diamètre, cloisonnées et ramifiées et d'hyphes hyalines à paroi mince, de 2 à 3 µm de diamètre, également ramifiées et cloisonnées. Nombreux cristaux sur et entre les hyphes. Pas de cortex basal.

Spinules brunes aigües, étroites et très longues, 90-170-(190) x (4)-6-8 µm, naissant à différentes hauteurs, émergentes jusqu'à 100 µm. Des hyphes hyalines et grêles de

2 µm de diamètre grimpent souvent le long de ces spinules.

Hyménium formé de basidioles, de basides assez souvent un peu constrictées, 12-17-(19) x 4-5 µm à 4 stérigmates de 5 µm et de pseudoacanthophyses à paroi mince ou légèrement épaissie, 10-13-(20) x 3-5 µm, avec quelques diverticules terminaux (4 à 6 le plus souvent) de 2 à 3 µm de long. Basides et pseudoacanthophyses sont abondantes dans la partie jeune, ocre jaune, du basidiome et beaucoup plus rares dans la partie agée, cannelle.

Spores (observées sur les coupes car sporée non obtenue) cylindriques, (6)-6,5-7,5-(8) x 2,8-3-(3,2) µm, à apicule souvent bien marqué, hyalines, non amyloides.

Sur support indéterminé, Mt Kenya Forest, Kenya, 31 mars 1963, leg. K. Bjørnekaer. Holotype: Afr.22 (C); petit isotype adressé par K. HAUERSLEV à J. BOIDIN en 1973 (LY 7280).

DISCUSSION :

Hymenochaete hauerslevii nov.sp. est un champignon parfaitement caractérisé par ses pseudoacanthophyses qui rappellent celles de *Stereum australe* Lloyd (voir J. BOIDIN, 1960, p. 67). Aucune espèce d'*Hymenochaete* possédant de tels éléments hyméniens n'a été décrite précédemment. Un autre caractère intéressant est la grande ressemblance de cette espèce nouvelle avec *H. cinnamomea* (Pers.)Bres. : tout d'abord la couleur cannelle de la surface mais surtout la structure lorsque *H. cinnamomea* est jeune et à l'état unistratifié, c'est-à-dire le contexte lâche, les spinules longues, étroites et très émergentes; même la taille des spores rapproche les deux espèces. Cependant, aucune des récoltes européennes de *H. cinnamomea* unistratifié que nous avons pu examiner ne présente de pseudoacanthophyses, ce qui permet de distinguer aisémment *H. hauerslevii*. Il serait intéressant de rechercher si des spécimens avec pseudoacanthophyses ne se cachent pas parmi les récoltes américaines unistratifiées de *H. cinnamomea*.

ABSTRACT

In this paper, species of *Hymenochaete* were studied which possess hymenial hyphidia with "pinnatifid tips" according to BURT's terminology. To the known species with such a feature, *H. pinnatifida* Burt and *H. digitata* Burt, two species are added : *H. acanthophysata* nov.sp. and *H. hauerslevii* nov. sp.. Although these species seem to form a group of their own in our study, it would certainly be excessive to consider them as a natural grouping. We give below a diagnostic key which summarizes the main characters of each species :

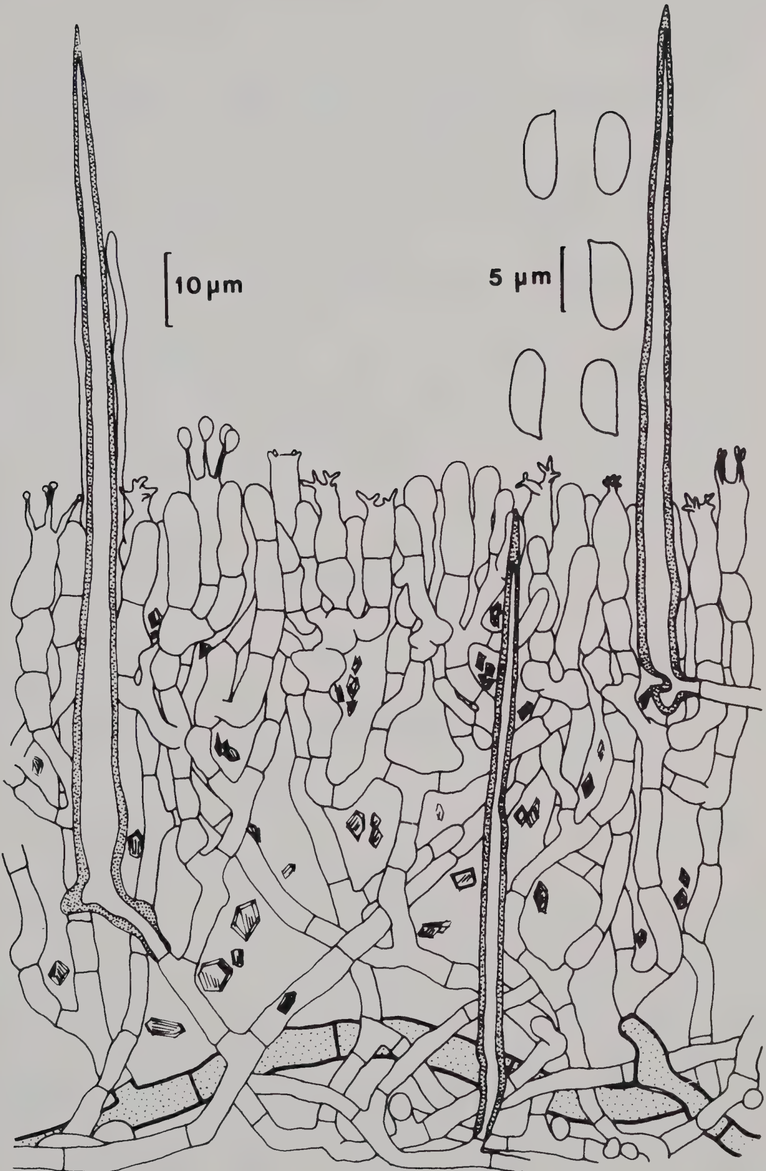

Figure 6 : Hymenochaete hauerslevii

1- Cortex present (Cuticle *sensu* REEVES and WELDEN, 1967) 2

1- Cortex absent 3

2- No tomentum (abhymenial hairs); dark subhymenium of tightly interwoven hyphae, context not stratose (but a two-layered stage observed in LY 8091 from Guadalupe) and dendrophyses. West Indies, Gabon, Central African Republic and Guadalupe .... *H. pinnatifida* Burt.

2- Tomentum present; no dark subhymenium; context stratose of several hymenial layers and particular pseudoacanthophyses with dendrophyse-like apicis. Panama .... *H. digitata* Burt.

3- Context not stratose of loosely interwoven hyphae; slender setae 90-170-(190) x (4)-6-8 µm and pseudoacanthophyses hyaline; spores (6)-6,5-7,5-(8) x 2,8-3-(3,2) µm. Kenya .... *H. hauerslevii* Léger nov. sp.

3- Context stratose (but found frequently in first-stratum stage); setae somewhat massive, 40-70 x 7-8,5 µm, and very numerous acanthophysate hyphae; spores 4-4,5-(5) x 1,5-1,8 µm. Ivory Coast and Gabon .... *H. acanthophysata* Léger nov. sp.

ACKNOWLEDGEMENTS

Thanks are due to H. ROMAGNESI for the translation of Latin diagnoses and to Dr. K. HAUERSLEV for sending the specimen from Mt Kenya. We are also very grateful to Dr. J. ERIKSSON and Dr. A.L. WELDEN for critical review and to the Curator of the Farlow Herbarium for the loan of specimens.

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MYCOTAXON

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CHLORIDIUM AND SOME OTHER DEMATIACEOUS HYPHOMYCETES GROWING ON DECAYING WOOD. CORRECTIONS AND ADDITIONS

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Soon after publication of our paper under this title (*in* Stud. Mycol. *13.* 1976) our attention was drawn to some homonymies (Index of Fungi *4:* 469. 1978) and incompletenesses which we wish to correct here.

CHAETOSPHAERIA FUSISPORA W.Gams & Hol.-Jech., *l.c.* p. 45 is a homonym of
Chaetosphaeria fusispora (Kawamura) Hino *in* Bull. Miyazaki Coll. Agric. For. *4:* 191. 1932 (Syn. *Miyoshia fusispora* Kawamura; *Miyoshiella fusispora* (Kawamura) Kawamura); a possibly congeneric fungus with much wider ascospores, 26-43 x 6-10 µm - and
Chaetosphaeria fusispora P. Larsen *in* Dansk bot. Ark. *14*(7): 7. 1952; which probably belongs to *Chaetosphaerella* E. Müll. & C. Booth.

We therefore rename our fungus
Chaetosphaeria fusiformis W.Gams & Hol.-Jech. *nom. nov.*
replaced synonym: *Chaetosphaeria fusispora* W.Gams & Hol.-Jech *in* Stud. Mycol. *13:* 45. 1976.

The genus *CYLINDROTRICHUM* (*l.c.*, p. 48) was incompletely treated.
Species published before our paper include:
Cylindrotrichum proliferum Matsushima, Icones Microfungorum a Matshushima lectorum: 47. 1975,
Cylindrotrichum triseptatum Matsushima, *l.c.*: 48. 1975 and
Cylindrotrichum triseptatum M.B.Ellis, More dematiaceous Hyphomycetes: 470. 1976 (a homonym) $\equiv$ *C. ellisii* Morgan-Jones *in* Mycotaxon *5:* 490. 1977.

Since our publication four further species were described:
Cylindrotrichum oblongisporum Morgan-Jones *in* Mycotaxon *5:* 487. 1977, which should be compared with our

C. zignoëllae,

Cylindrotrichum gorii Lunghini *in* Micol. ital. *8:* 25. 1979, distinct from the previously known species by smaller, often slightly curved conidia, 5.7-9.9 x 1.9-3.0 µm,

Cylindrotrichum helisciforme Marvanová *in* Trans. Br. mycol. Soc. *73:* 368. 1979, with tricuspidate apical cells of the conidia, and

Cylindrotrichum curvatum Morgan-Jones *in* Mycotaxon *12:* 250. 1980, with curved conidia, 10-14 x 2.5-4.0 µm.

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TRICHOPHYTON RAUBITSCHEKII, SP. NOV.

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A urease-positive *Trichophyton* isolated from skin scrapings has been found to be sufficiently different from existing taxa within this genus to warrant its establishment as a new species, *T. raubitschekii*.

MATERIALS AND METHODS

TEST ORGANISMS - Forty-one isolates of a urease-positive *Trichophyton* recovered from skin scrapings and 10 isolates each of *T. rubrum* and *T. mentagrophytes* recently obtained from clinical specimens were used in this study. The purity of all isolates was established by single spore isolation and other methods (2,5,8). The identification of *T. rubrum* and *T. mentagrophytes* isolates was established by standard methods (6,9) before they were selected for this investigation. All isolates were maintained on peptone-dextrose agar (Sabouraud dextrose agar: 4% crude glucose, 1% Neopeptone, 2% agar) at 26-28°C. Seven-day-old cultures on this medium served as the source of inocula for all morphologic and physiologic tests.

MORPHOLOGY - The gross and microscopic morphology of each isolate was observed after 2 and 4 weeks' incubation on peptone-dextrose agar at 26-28°C.

GROWTH AND PIGMENT FORMATION - A pinpoint inoculum from a 7-day-old culture was transferred to the center of each agar slant. All slants were incubated at 26-28°C. The extent of growth and pigmentation on bromcresol purple-casein dextrose agar (5) and corn meal-dextrose agar (3) were assessed 7 days after inoculation. The extent of growth on lactose agar (4) was noted at weekly intervals for 3 weeks.

UREA HYDROLYSIS TEST - Ability to hydrolyze urea within 7 days was determined by the urea broth method of Kane and Fisher (7).

HAIR PERFORATION TEST - Following the technique described by Ajello and Georg (1), autoclaved human hair was examined for wedge-shaped perforations at weekly intervals for 4 weeks.

MATING REACTIONS - Mating tests with strains of *Arthroderma simii* and *A. benhamiae* were performed according to the method of Stockdale (10) on the oatmeal-salts agar described by Weitzman and Silva-Hutner (11).

RESULTS AND DISCUSSION

Division: Fungi imperfecti
Form class: Hyphomycetes
Form order: Moniliales
Form family: Moniliaceae

Trichophyton raubitschekii Kane, Salkin, Weitzman et Smitka, sp. nov. Colonia in agaro peptone-dextrose, postquam 14 dies apud 26°C lapsi sunt, 28 mm in diam.fit; plana, tenuis, lenis usque ad granosum in textu, cum centro fulvo sublatoque. Pars aversa erat sanguinea (#3 in charta colorum Raynor Mycology RMCC). Margo coloniae erat distinctus cum angusta fascia sine colore.

Post 28 diebus, colonia erat 53 mm in diam.; plana, tenuis, lenis, cum centro sublato exquo sulci radiantes ad peripheriam pertinuerant. Tres zonae colorum notatae sunt. Centrum erat submurinum, (RMCC #117) quod ad zonam mediam, colore grisea-sepiaceam (RMCC #106) pertinuit terminatumque ad aream peripheriam, lavendulo-griseam (RMCC #125). Margo erat distinctus cum fascia sine colore 3 mm in latitudinem. Pigmentum in parte aversa sanguineum (RMCC #3) remansit.

Sporulatio in agaro peptone-dextrose erat crebra et in primis et in subsequentibus subculturis. Macroconidia erant longa et angusta, 45-51 x 4.8-6.3 um, cum parietibus teribus, fines obtusi, et ex 5-9 cellulis composita. Microconidia erant in forma variabilia (clavata, subsphaeralia, globosa), 4.8-6.4 x 3.2-4.8 um, aut sesselia aut in brevibus conidiophoribus, a latere ferebantur. Holotypus OMH 1094, teleomorph ignotum.

Habitat: Man
Holotype: OMH 1094, isolated from human skin scrapings, Toronto, Ontario, Canada.

Living cultures of the holotype have been deposited in the American Type Culture Collection, Rockville, Maryland (accession number ATCC 42631); the University of Alberta Mold Hebarium, Edmonton, Alberta, Canada (accession number UAMH 4314); and the Medical Mycology Laboratory Culture Collection, Ontario Ministry of Health, Toronto, Ontario, Canada (accession number OMH 1094). The epithet T. raubitschekii was chosen to honor the late Dr. F. Raubitschek, dermatologist, medical mycologist, and teacher.

The colony on peptone-dextrose agar after 2 weeks at 26°C was 28 mm in diameter, flat, thin, velvety to granular in texture, with an elevated, buff-colored center (Figure 1A). The reverse was blood-red, #3 on the Raynor mycology color chart (RMCC: Commonwealth Mycological Institute, Kew, Surrey, England). The colony margin was distinct, with a narrow colorless band.

After 4 weeks the colony was 53 mm in diameter, flat, thin, velvety, with a raised center from which grooves radiated to the edge (Figure 1B). Three color zones were noted: a pale mouse-gray center (RMCC #117), a grayish sepia (RMCC #106) intermediate zone, and a lavender-gray (RMCC #125) peripheral area. The margin was distinct, with a 3-mm colorless band. The reverse remained blood-red (RMCC #3).

Sporulation on peptone dextrose agar was abundant in both primary and subsequent subcultures. Macroconidia were long and narrow, 46-51 x 4.8-6.3 um, with smooth, parallel-sided walls, blunt ends, and five to nine cells (Figure 2). Microconidia were variable in shape (clavate, subspherical, or globose), 4.8-6.4 x 3.2-4.8 um, and borne laterally, either sessile or on short conidiophores (Figure 3).

Teleomorph unknown.

Pronounced urease activity was observed within 7 days of incubation at 26-28°C. Growth on bromcresol purple-casein dextrose agar was restricted, and a reddish pigment developed in the center of the colony. Brown reverse pigmentation was observed on cornmeal dextrose agar. Growth on lactose agar was restricted after 3 weeks' incubation.

Mating of 12 isolates of T. raubitschekii with strains of A. simii mating type (A) resulted in the formation of either pseudogymnothecia or gymnothecia with immature, irregular asci. In contrast, no reaction occurred when the same isolates were paired with tester strains of A. benhamiae or mating type (a) of A. simii.

The key morphologic and physiologic features of T. rubrum, T. raubitschekii, and T. mentagrophytes are compared in Table 1. Trichophyton raubitschekii is similar to T. mentagrophytes in urease activity but differs in its inability to perforate hair in vitro, its restricted growth on bromcresol purple-casein dextrose agar, and its lack of sexual reaction with A. benhamiae. While resembling T. rubrum in its reddish pigmentation on glucose-peptone agar and sexual reaction with A. simii (A),

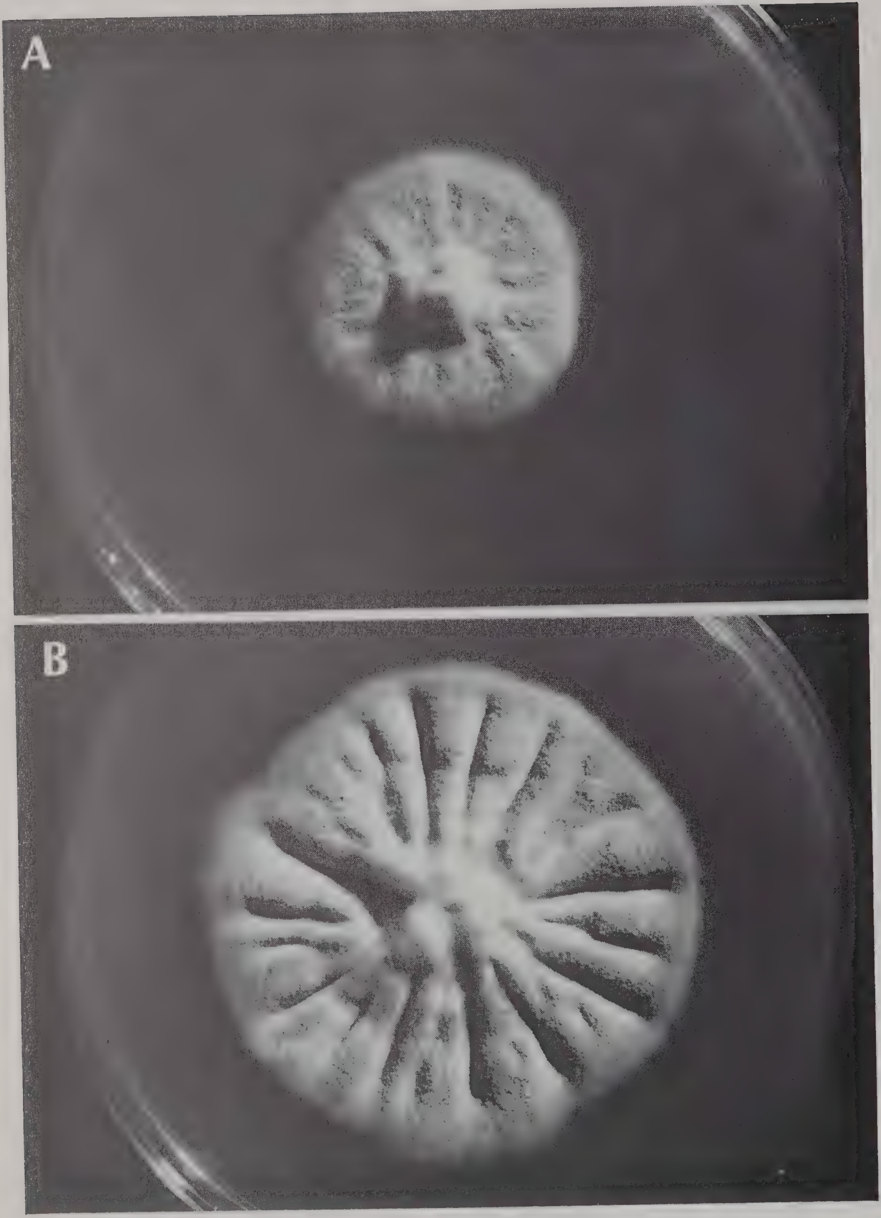

Figure 1: Culture of T. raubitschekii on peptone-dextrose agar at 26-28°C after (A) 2 weeks and (B) 4 weeks' incubation.

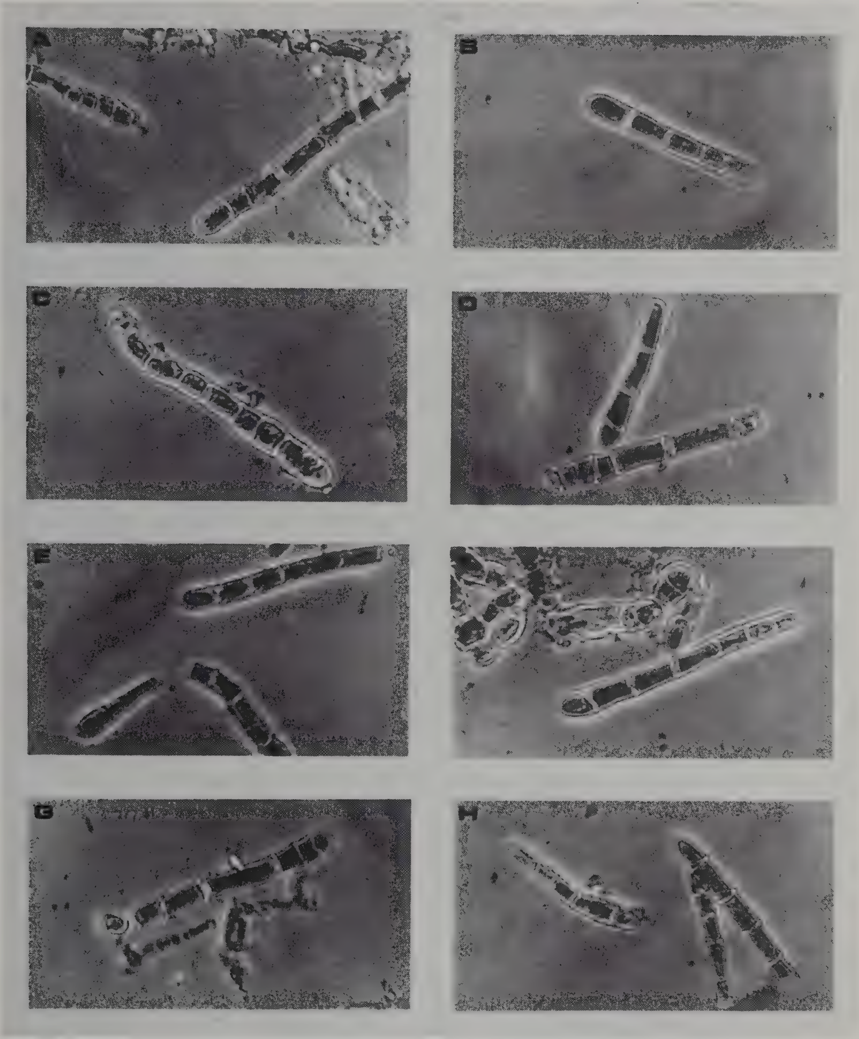

Figure 2: Macroconidia (A-H) on peptone-dextrose agar. Phase contrast, x 400.

T. raubitschekii differs from T. rubrum in four important characteristics: it is urease-positive; its growth is restricted rather than spreading on lactose agar; its pigmentation on casein dextrose agar is brown rather than red; and it produces abundant macroconidia.

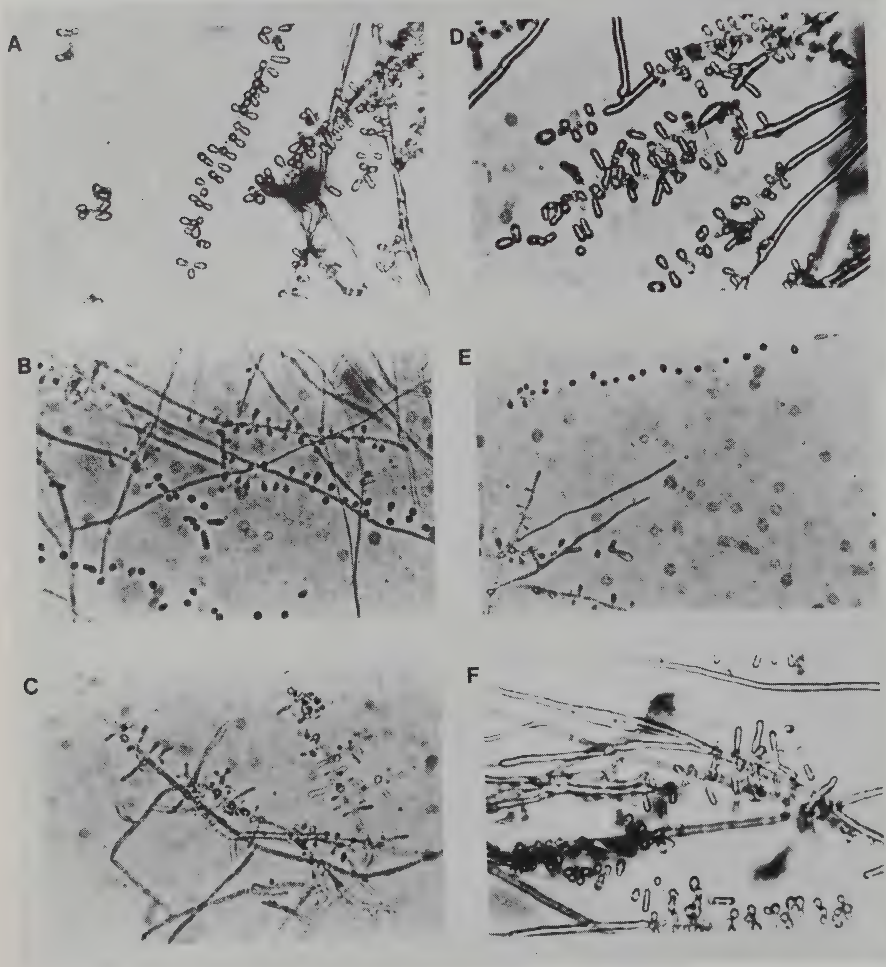

Figure 3. Microconidia (A-F) on peptone-dextrose agar, x 400.

Table 1. Comparison of morphologic and physiologic characters of *T. rubrum*, *T. raubitschekii*, and *T. mentagrophytes*

Character	*T. rubrum* (10)[a]	*T. raubitschekii* (41)	*T. mentagrophytes* (10)
Urease activity	Negative	Positive	Positive
Hair perforation	Negative	Negative	Positive
Pigment on cornmeal dextrose agar	Red	Brown	-
Growth on lactose agar	Spreading	Restricted	ND[b]
Growth on bromcresol purple-casein dextrose agar	Restricted	Restricted	Spreading
Macroconidia	Rare, pencil-shaped, 4-6 x 15-30 um	Abundant, pencil-shaped, blunt-ended, 4.8-6.3 x 46-51 um	Occasional, clavate, 6-8 x 20-50 um
Microconidia	Clavate, 2-3 x 3-5 um	Variable, 4.8-6.4 x 3.2-4.8 um	Variable, 3.6-4.2 x 2.2-2.8 um
Colony texture	Cottony, velvety	Velvety, granular	Cottony, velvety, granular, powdery

[a] Number of isolates used in this study.

[b] ND = not done in this study.

ACKNOWLEDGMENT

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CYRENELLA ELEGANS GEN. ET SP. NOV., A DIKARYOTIC ANAMORPH

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ABSTRACT

Cyrenella elegans Gochenaur is described and illustrated from sand around the base of the mushroom, *Laccaria trullisata* (Ellis) Singer. Its bright orange colony bears hyphae with clamp connections, small, obovate, dikaryotic conidia with 3 or 4 apical appendages and a single basal one, and clusters of globose chlamydospores. Monokaryotic blastospores may be produced. The organism is oxidative, mesophilic and acidophilic, utilizes nitrate, and requires the vitamins p-aminobenzoate and thiamine.

INTRODUCTION

Several *Rhodotorula*-like isolates were obtained from dilution plates prepared with sand scraped from the submerged stipe of *Laccaria trullisata.* One of these colonies during subculture was found to produce hyphae with clamp connections and small appendaged conidia. A new form genus is introduced for this isolate as no fungus with similar characteristics appears to have been described in the literature.

The holotype, a desiccated agar culture (No. 785), is deposited in The New York Botanical Garden Herbarium (NYBG), Bronx, N. Y. Living representative strains (isotypes) are deposited in The American Type Culture Collection (ATCC), Rockville, Md. and The National Culture Collection (NCC), Commonwealth Mycological Institute, Kew, England.

MATERIALS AND METHODS

Morphological descriptions are based on a strain that developed from a single conidium obtained from the original isolate. This dikaryon and a cloned blastosporic strain derived from it were cultured on 2% malt extract agar with 2% glucose (MEA) at 20°C and examined microscopically using brightfield and phase optics. Measurements of microscopic structures are the mean of 50 determinations ± the standard deviation. Colors refer to plates in the Methuen Handbook of Colour (10).

Nutritional studies using the dikaryon and blastosporic cultures employed a basal medium composed of Bacto-Yeast Nitrogen Base without Amino Acids and Ammonium

Sulfate (Difco Laboratories, Chicago, Il.) and solidified with Bacto-Purified Agar. This was supplemented with glucose (1%) in tests for utilization of various nitrogen sources and with Bacto-Vitamin Free Casamino Acids in tests for utilization of various carbon sources. All basal media and test compounds were filter sterilized except compounds 17 through 23 (Table II) which were heat sterilized at 121°C. Vitamin requirements were determined for cultures grown on Bacto-Vitamin Free Yeast Base solidified with BBL-Ion Agar No. 3 (Baltimore Biological Laboratories, Cockeysville, Md.) and supplemented with 0.2% Bacto-Vitamin Free Casamino Acids and the appropriate vitamins. Vitamin-depleted inoculum was used.

Environmental studies, using the blastosporic stage only, were done in liquid culture employing a medium composed of Bacto-Casamino Acids (0.5%) and glucose (1%). Growth was measured spectrophotometrically at a wave length of 450 nm. Additional temperature data were collected using the dikaryon grown on MEA.

Chlamydospore germination was studied using the technique employed by Newell and Fell (12) for *Rhodosporidium* teleospores. Chlamydospores produced in malt extract broth were collected by centrifugation, washed several times, resuspended in sterile distilled water and stored for up to 5 months at room temperature and 7°C. Aliquots were removed at various times and streaked on Bacto-V8 Juice Agar and MEA, incubated at 12°C and 25°C, and examined periodically over 4 days.

Nuclear number was determined using Furtado's Toluidine Blue (5). Cells were grown on MEA for 2 to 5 days at 30°C and then stained in wet mounts or smeared on cover glasses and pretreated for 5 min with 1N HCl at 60°C before being stained.

TAXONOMY

CYRENELLA Gochenaur, forma-gen. nov., nomen anamorphosis, Deuteromycotina, hyphomycetes pertains.

Mycelium ex hyphis hyalinis, ramosis, leviter tunicatae compositum zygodesmatibus praeditae. Conidiophora hyalina, macronemata, solitariae vel congregatae, erecta, irregulariter ramosa. Cellulae conidiogenae monoblasticae, apicalia et lateralia, globosae, ovoideae vel cylindricae vel mixtae, vacuae post dehiscentem conidiorum. Conidia hyalina, obovata, et cum brachiis apicalibus radiantibus, 2-5 et uniappendici basilari. Chlamydosporae et blastosporae sint productae.

Species typica: *Cyrenella elegans* Gochenaur

ETYMOLOGY: From the Greek, *Cyrene*, a mythical water sprite, in reference to the probable habitat of the fungus and the resemblance of its conidia to those of the aquatic hyphomycetes.

CYRENELLA ELEGANS Gochenaur, forma-sp. nov. Figs. 1-2.

Coloniae in agaro maltoso post dies decem ad 20°C 4-5mm diam. attingentes, humectae, calendulinae, compactae, in centrum acervulatum, marginis planis, hyphis aereis raris. Hyphae immersae leves, zygodesmatibus praeditae, ad 2μm crassae. Conidiophora hyalina, macronemata, solitaria vel congregata, erecta, irregulariter ramosa, ad 100μm longa, 3-4μm latae. Cellulae conidiogenae monoblasticae, apicalia et lateralia, ovoideae vel cylindricae vel mixtae, vacuae post dehiscentem conidiorum, 5-12μm longae, 3-4μm latae. Conidia hyalina, unicellularia, binucleolata, 10 x 4μm, cum brachiis apicalibus radiantibus 3-4, 13-20μm longis, 1μm latis ad basem et 0.5μm latis ad apicem, et uniappendici eccentrica basilari, 7-11 x 0.8μm. Chlamydosporae abundae, solitariae et catenatae, intercalares et terminales, frequenter gregarae, hyalinae vel melleae pallidulae, binucleolatae, globosae vel subglobosae leves et crassitunicatae, 5.5-6.5μm latae. Status sexualis ignotis.

In arena, sub *Laccaria trullisata*, Hempstead Lake State Park, Long Island, New York, October, 1978. Holotypus cultura pura siccata (numero 785), NYBG Herb.

ETYMOLOGY: From the Latin *elegans*=graceful, describing the appendages of the conidia.

DEVELOPMENT

Germination of the conidia of *C. elegans* occurs within 24 hr on MEA at 20°C. One to 4 germ tubes arise apically between the appendages and/or from the base, but rarely from the lateral walls. Clamped septa and branches develop where the germ tubes emerge from the conidium. As the colony ages, conidia may germinate in place producing apically, laterally or from the base, one or more conidiogenous cells that develop conidia (Fig. 2C). Cytoplasm flows into the conidiogenous cell leaving the original conidium empty. This process may continue through several cycles, so that short chains of empty conidia are common. As a result of this proliferation, the color of the central area of the colony is diluted and much lighter than the periphery (Fig. 2A). Growth is slow. *Colonies* attain a diameter of 3 mm in 7 da and approximately 24 mm in 35 da. They are Persian to chrome orange (6A 7-8) with a raised, rugulose central region consisting of pulvinate masses of conidiophores and conidia and a narrow plane margin. With age, a broad, radiately wrinkled periphery composed of mycelium and chlamydospores develops (Fig. 2A). It is somewhat fiberous in appearance with small mounds of sporulating cells scattered over the surface or coalesced to form larger irregular or wedge-shaped patches. The surface is moist. Aerial hyphae are rare or absent; when present they are usually aggregated into tufts. The *mycelium* is hyaline and consists of sinuous and straight hyphae of uniform width, 2.0±0.3μm diam, with smooth, slightly thickened walls. Septa with clamp connections (Fig. 2B) first occur approximately 35±11μm from the tip and then at intervals of approximately 50μm. The cells are binucleate. A dolipore apparatus was not revealed in preparations stained with ammoniacal Congo-Red (11).

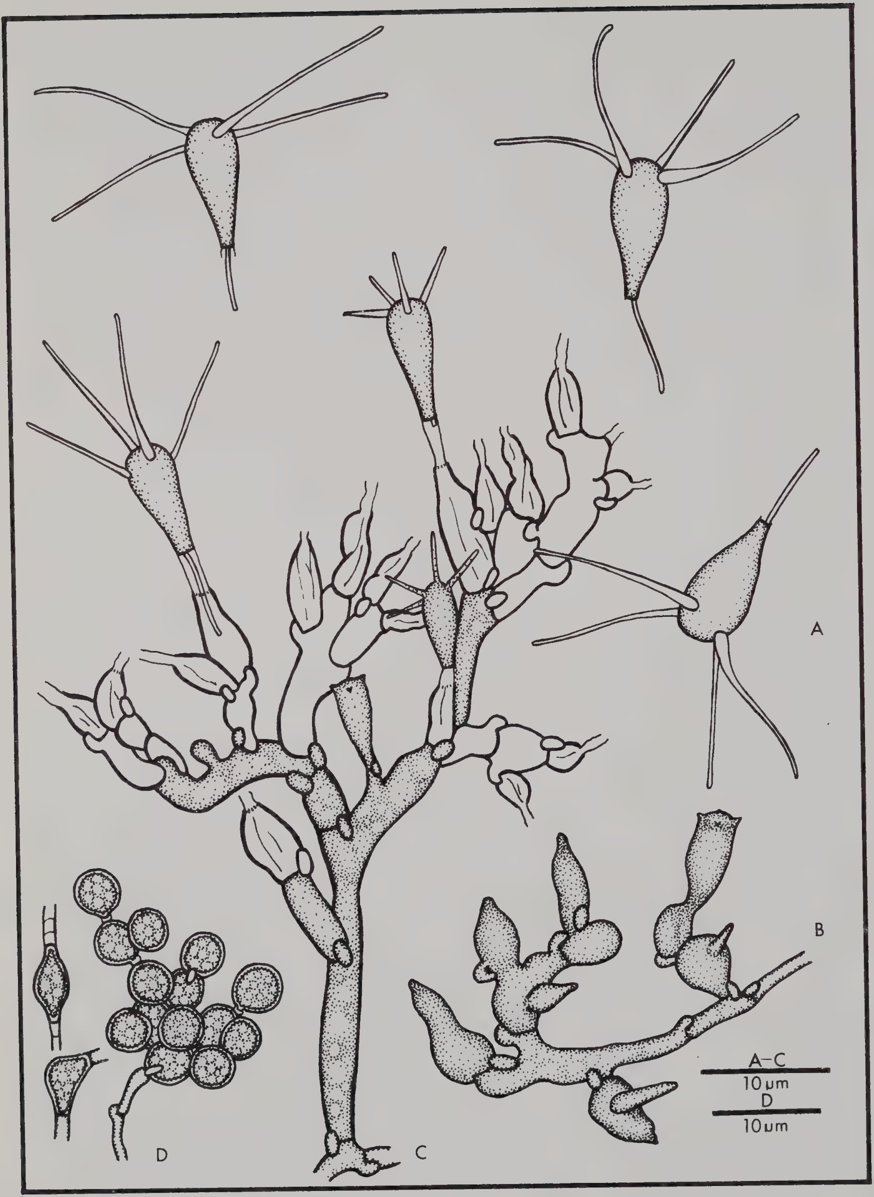

Fig. 1. Cyrenella elegans.
(A) Conidia. (B) Stages in the development of conidiogenous cells. (C) Mature conidiophore. (D) Single and clustered chlamydospores. Unstippled areas are devoid of cytoplasm.

Adventitious simple septa are common in older hyphae and coralloid or haustorial branches similar to those shown by Olive (13) for *Filobasidium* may occur.

Conidiophore development begins within 2-3 da. The conidiophores arise as erect, branched hyphae indistinguishable at first from the vegetative cells. They are hyaline, of variable length and produce thumb-shaped terminal and lateral branches that stain intensely with basic dyes (Fig. 1B). These branches are separated from the conidiophore early in development by clamp connections. They also may be produced individually along the vegetative hyphae (Fig. 2B) or less commonly from a clamp. They may differentiate directly into conidiogenous cells or may branch once or twice, each branch becoming a conidiogenous cell separated from its parent cell by a clamped septum. The irregularly branched conidiophore at maturity (Fig. 1C) is generally less than 100µm tall, 3-4µm wide at the base and is best observed using phase contrast optics since its upper half consists of cells devoid of cytoplasm and somewhat collapsed. Conidiophores are often aggregated into sporodochial-like clusters that arise from a basal mass of intertwined hyphae and chlamydospores. The conidiophores produce single or clusters of 2-3 conidiogenous cells laterally and terminally along their branches. The *conidiogenous cells* are phialide-like, binucleate, have a thick-walled body and a thinner-walled neck that is approximately 1-4µm long and 1-2µm wide. They vary in form from globose to ampulliform to cylindrical and measure 2-4µm wide, 5-12µm long including the neck. Each produces a single conidium.

Mature conida appear within 4-5 da. *Conidia* (Fig. 1A) are blastic, orange in mass but hyaline by transmitted light, binucleate (Fig. 2C), obovate, thin-walled, 10 x 4µm (9.7±1.2 x 4.2±.5µm) and bear 3-4 long, narrow, divergent, flexible, apical appendages, 16±2.4µm long, 1µm wide at the base and tapering to 0.5µm wide at the apex, and an eccentric basal appendage of uniform width, 8.9±2.1 x 0.8µm. At 20°C, approximately 33% of the conidia examined had 3 apical appendages; 66% had 4. At temperatures above 25°C, about 15% of the conidia had one, 2 and 5 arms.

Chlamydospores (Figs. 1D, 2D) appear after 3 da. They are single and catenulate and arise terminally, intercalary, or less commonly from clamps. They typically form in large compact clusters behind the margin of the colony and just above or below the agar surface. They are subglobose to globose, 6±0.4µm diameter, binucleate, hyaline to pale amber, thick-walled and filled with guttulae. Single ones are often oval and/or unsymmetrical and borne between several adventitious septa that form as the cytoplasm retracts into the developing chlamydospore.

Chlamydospores germinate within 3 da at 20°C (Fig. 2E). A single germ tube that branches and develops clamps where it exits from the spore is produced and a typical colony with conidia develops within 5 da. Chlamydospores remain viable after storage for up to 5 mo at room temperature in distilled water. Those held at 7°C exhibited a progressive

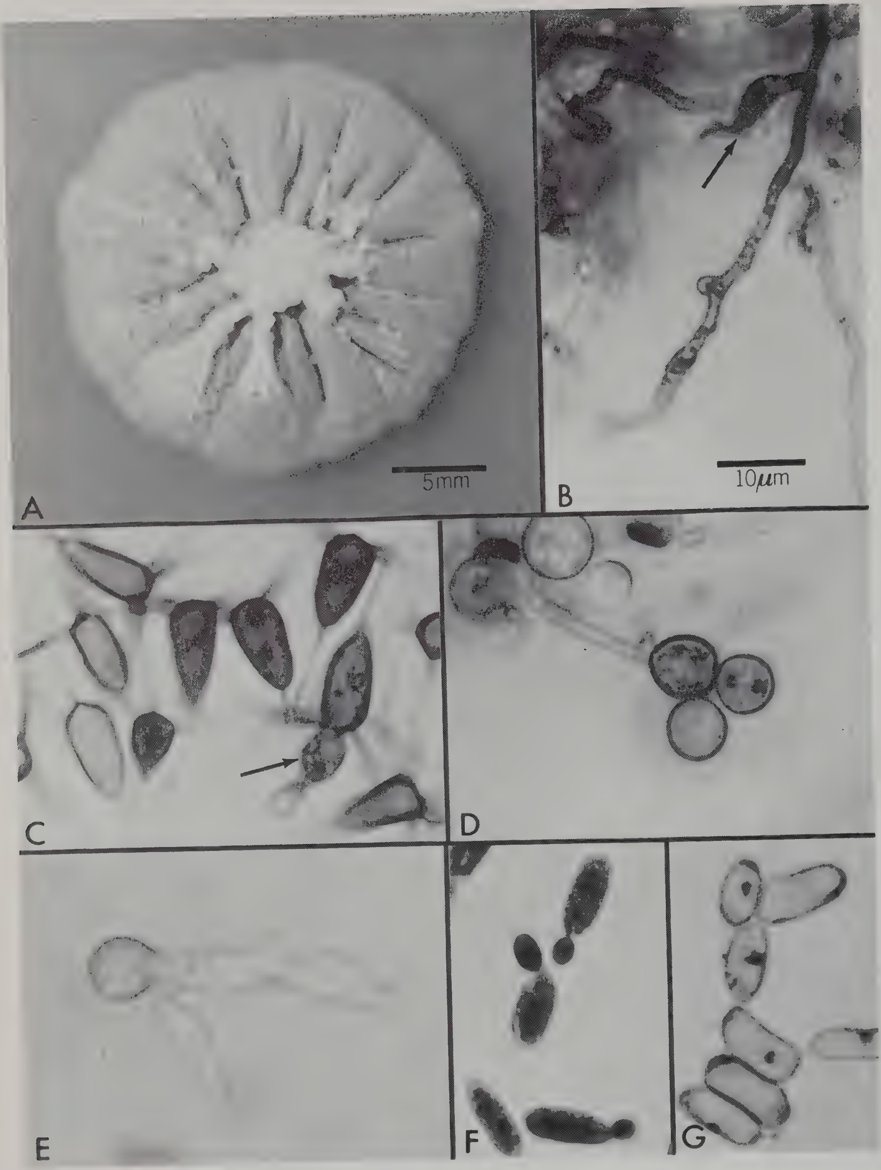

Fig. 2. Cyrenella elegans.

(A) Colony on malt extract agar after 35 da. at 20°C. (B) Vegetative hypha with a clamp connection. Arrow designates a young conidiogenous cell. (C) Binucleate conidia. Arrow designates a young conidiogenous cell and secondary conidium produced during in situ germination. Three empty conidia appear on the left.

decrease in the percent germinating after 45 da storage and showed no germination after 5 mos. Karyogamy, probasidia and soredia were not induced by these conditions, nor do these spores resemble, in either coloration or mode of formation, the teleospores produced by members of the genus *Rhodosporidium* (2, 3, and comparison in culture with *Rh. dacryoidum* Fell, Hunter, Tallman ATCC 24502 & ATCC 24503). In view of the above, it is considered likely that these structures are true chlamydospores and not the teleomorphic state of *C. elegans*.

Dedikaryotization occurs spontaneously, but infrequently, as the culture ages; a uninucleate yeast phase results. It can be detected readily by streaking material onto an agar medium containing raffinose, a sugar utilized less well by the filamentous stage. Origin of the blastospores is unknown. Subjecting the dikaryon to flooding with water or anaerobic or microaerobic conditions while growing it on media with various C/N ratios and low or abundant in nutrients failed to consistently induce the yeast phase.

The *yeast colonies*, like the dikaryon, grow slowly, reaching a diameter of 8-10 mm on MEA at 20°C after 30 da. They are slightly elevated when viewed in cross section and show faint radial lines. Their surface is semi-glossy, deep orange to Persian orange (6A8-7A8) in color with a slightly deeper carrot red reverse (7B7). The yeast cells (Fig. 2F-G) are unicellular, monokaryotic, non-encapsulated, elliptical to cylindrical with rounded ends, less commonly obclavate, $9.0 \pm 1.8 \times 3.2 \pm 0.8 \mu m$, and reproduce by terminal and subterminal budding. Fermentation is absent. In ME broth, most cells are single and only rarely are short chains of cells observed. No pellicle is produced.

Evidence suggests that the nuclei in the dikaryon are identical. A dikaryophase is not reestablished when yeast cells from randomly selected colonies are mixed on cornmeal agar. However, it develops spontaneously in every cloned yeast colony that is over a few days old. Cells in the center of a colony at the agar surface become binucleate. It is uncertain whether these occur following conjugation between two cells or by failure to bud during mitosis. Observation of empty single yeast cells with an attached binucleate conidium suggests that the latter is the case. A sparse mycelium always develops under every yeast colony but its further expansion is limited unless the overlaying cells are scraped away. All cells on the surface of a colony remain monokaryotic so that the yeast phase can be maintained indefinitely in culture but always contaminated eventually with the dikaryon.

(D) Binucleate chlamydospores. (E) Germinating chlamydospore. (F) Budding blastospores. (G) Uninucleate blastospores. Material in photographs B-G was stained with toluidine blue. Cells in photograph G were pretreated with 1N HCl for 5 min at 60°C.

NUTRITION

C. elegans is an acidophilic, mesophilic, obligate aerobe. Growth occurs over a wide range of H-ion concentrations. It is best between pH 3.5-6.0 and absent below pH 2.5 and above pH 7.4. Conidia do not germinate at 5°C and 37°C. Pigmentation is more intense and colonial and cellular development best between 18-23°C. Growth is fastest at 30°C; absent above 34°C.

Table I. Growth of *Cyrenella elegans* on various nitrogen sources[a)]

Compound	Growth	Compound	Growth
1. Potassium nitrate	+	6. Glutamic acid	+
2. Potassium nitrite	-	7. Asparagine	+
3. Ammonium sulfate	+	8. Casamino acids	++
4. Urea	+	9. Gelatin	++
5. Aspartic acid	+	10. Sodium Caseinate	++

[a)] Cultures were incubated for 5 da at 28°C.

++ Growth equal to growth on casamino acids
+ Growth weak but better than growth on a medium lacking a nitrogen source
- No growth

C. elegans utilized all nitrogen sources tested with the exception of potassium nitrite (Table I). Growth and development are best on a mixture of amino acids. The proteins, gelatin and sodium caseinate, are utilized but diffusible hydrolases were not detected when colonies on these substrates were flooded with acidified $HgCl_2$. A variety of compounds can serve as the carbon-energy source (Table II). Growth and development are best on glucose or fructose. Krebs Cycle acids (Nos. 37-38) are assimilated but not compounds with ester linkages (Nos. 23-24). Among the polysaccharides (Nos. 17-22), only the fructosan inulin and the starches (Nos. 18-19) were weakly degraded. Diffusible exoenzymes were not detected when colonies growing on the latter compounds were flooded with an IKI solution. Patterns of carbon and nitrogen assimilation by the blastosporic and dikaryotic stages are identical. The exogenous vitamins, p-aminobenzoate (PABA) and thiamine, are required for growth of both the mycelial and yeast phases. High concentrations of folic acid can be substituted for PABA but not a mixture of amino acids and purines.

DISCUSSION

Cyrenella elegans is a member of the Basidiomycotina because it produces mycelium with clamp connections but the absence of a telemorphic state makes its phylogenetic position in the subdivision uncertain and any attempt at ordinal placement a purely speculative venture.

Table II. Growth of *Cyrenella elegans* on various carbon-energy sources[a)]

	Compound	Growth		Compound	Growth
1.	Xylose	++	22.	Chitin	-
2.	L-Arabinose	++	23.	DNA	-
3.	Ribose	-	24.	Triglyceride	-
4.	Glucose	++	25.	Fucose	-
5.	Fructose	++	26.	L-Rhamnose	++
6.	Mannose	++	27.	Glucosamine	-
7.	Galactose	-	28.	Ethanol	-
8.	L-Sorbose	-	29.	Glycerol	++
9.	Trehalose	+	30.	Erythritol	-
10.	Sucrose	++	31.	Sorbitol	++
11.	Maltose	++	32.	Mannitol	++
12.	Melibiose	-	33.	Inositol	-
13.	Cellobiose	+	34.	Galactitol	-
14.	Lactose	-	35.	Acetate	-
15.	Melezitose	++	36.	DL-Lactate	-
16.	Raffinose	+	37.	Succinate	++
17.	Inulin	+	38.	Citrate	+
18.	Amylose	+	39.	Arbutin	+
19.	Amylopectin	+	40.	Salicin	+
20.	Pectin	-	41.	Vanillin	-
21.	Cellulose	-	42.	Casamino acids	-

[a)] All compounds were D-isomers except where noted. Cultures on compounds 17-24 were incubated for 14 da at 28°C, all others for 5 da at 28°C.

++ Growth equal to or better than growth on glucose
+ Growth weak but better than growth on a medium lacking a carbon source
- Growth equal to or less than growth on a medium lacking a carbon source

The blastosporic stage could be readily accommodated in the genus *Rhodotorula* (14) if the dikaryophase were lost. It resembles *R. aurantiaca* (Saito) Lodder and *R. lactosa* Hasegawa in producing cylindrical cells, in colony color, in utilizing nitrate, cellobiose and maltose and in requiring PABA and thiamine. It differs from the former in being galactose negative and L-rhamnose and raffinose positive and from the latter in being unable to utilize melibiose and lactose. The requirement for PABA is confined to a very few wild-type fungi, certain species of *Rhodotorula*, *Blastocladia pringsheimii* Reinsch and single strains of *Saccharomyces cerevisiae* Hansen (4). Because this requirement is so uncommon, there appears to be strong selection pressure against such fungi in nature. Its simultaneous occurrence in *Rhodotorula* and *Cyrenella* may signify a much closer relationship between these genera then is evident simply on the basis of similarities in morphology and nutritional patterns.

C. elegans was obtained from sand along the shore of a fresh water lake in an area that is regularly submerged each spring for several months. Even though it came from a terrestrial habitat, *C. elegans* has several characteristics in common with organisms isolated from aquatic environments. Its thin-walled, tetraradiate-like conidia bear appendages in a pattern reminiscent of that evolved by many fresh and a few salt-water fungi. They are remarkably similar to the basidiospores of the marine fungus *Nia* in size and shape but not development (9) and superficially resemble the conidia of aquatic hyphomycetes belonging to the genera *Acaulopage* Drechsler, *Clavatospora* S. Nilsson and *Clavariana* Nawawi. Diffusible exoenzymes are a characteristic feature of terrestrial fungi (1, 8) but would be a distinct disadvantage for an aquatic organism since such proteins and their digestion products would be lost into the water. *C. elegans* produces no diffusible hydrolases when utilizing starch, gelatin and casein. Since its hydrolases must be retained in protective association with the cell wall, it would be well adapted for life in dilute aqueous environments. Finally, *C. elegans'* requirement for PABA occurs less frequently among terrestrial fungi than among aquatic ones. In *R. aurantiaca*, for example, only strains of marine origin demonstrate an absolute need for PABA (14). These features suggest that *C. elegans* is not a terrestrial fungus but is an aquatic or possibly an amphibious one, whose propagules were trapped in the sand as the lake water receded, persisting there until isolated several months later.

If *Cyrenella* is an aquatic genus, it is an extremely uncommon one. Dr. R. Bandoni of the University of British Columbia (personal communication) reports that *C. elegans* appears to be identical to a fungus he collected from a driftwood chip on the shore of the Iowa River about 25 years ago. Other workers who have examined the conidia report they do not remember seeing spores of exactly this type in foam samples nor have illustrations of these spores appeared in the many works describing propagules from this environment (6, 7). With its slow growth rate in culture, superficial resemblance to *Rhodotorula* and tiny conidia, it is understandable why a *Cyrenella* could be overlooked.

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REVUE DES LIVRES

par

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GENERA OF HYPHOMYCETES, par J.W. CARMICHAEL, W.B. KENDRICK, I.L. CONNERS and Lynne SIGLER, 390 p., 129 pl., 8°, reliure spirale, 1980, The University of Alberta Press, Edmonton, Alberta, Canada. Prix $ 21.-.

Cet ouvrage est une seconde édition entièrement revue et complétée de la première psésentation par les premiers auteurs d'une compilation illustrée et critique de la littérature originale des genres de Hyphomycètes dans *The Fungi* de Ainsworth, Sparrow and Sussman, Tome IV A, en 1973. Les auteurs ont recensé cette fois plus de 2000 noms de genre, contre 1541 en 1973. Les 61 planches de figures d'alors sont devenues 129 aujourd'hui. Après une introduction sur la méthode et la classification des types conidiogénétiques, on y trouvera une liste documentée des noms de genres, avec date, référence, type morphologique, hôte, espèce type, statut nomenclatural et synonymie, avec références. Cette liste distingue les genres acceptés par les auteurs des noms rejetés ou douteux. Viennent ensuite les illustrations, soit reproduites des descriptions originales, soit dessinées à partir de publications récentes ou encore du type. Les 853 figures représentent pour la plupart les espèces types des genres et sont identifiées à l'espèce. Le grossissement n'est pas donné mais n'est pas indispensable à ce niveau. Suivent encore 5 index: un index des genres par type conidiogénétique, un index des connections entre téléomorphes (stades sexués) et anamorphes (stades conidiens), une liste bibliographique, une liste des abréviations et une liste des figures. Les auteurs ont suivi la nomenclature illégale basée sur Persoon, *Synopsis Fungorum*, de 1801 comme point de départ, contrairement à l'art. 13, mais combien souhaitée par beaucoup. Le livre remplace les guides des genres publiés jusqu'à présent. Il est fort bien imprimé. Sa reliure en spirale s'inspire de celle du Barnett, *Illustrated genera of Imperfect Fungi*, mais on pourra le regretter. Vu son évidente utilité et son prix assez modique, le livre aura sans doute une large diffusion.

Les auteurs l'ont dédié à la mémoire de *Luella K. Weresub*, mycologue du Biosystematics Research Institute d'Ottawa, tant appréciée de tous.

CHAMPIGNONS D'EUROPE, par M. SVRCEK et J. KUBICKA, adapté en français avec coll. de G.L. HENNEBERT et al., 296 p., 448 ph. col., 8°, cartonné, 1980. Ed. Elsevier-Sequoia, B-1940 St Stevens-Woluwe, Belgique.

Ce guide des champignons est remarquable par le grand nombre d'espèces décrites - 448 - chacune convenablement illustrée d'une photo en couleurs dans le milieu naturel. Les descriptions sont précises et donnent les dimensions sporales. Une introduction illustrée retrace la structure des champignons et leur classification, donne les conseils au récolteur et le documente abondamment sur la toxicité des champignons. Offrant un éventail exceptionnellement large des champignons d'Europe, tant de montagne que de plaine, ce guide surpasse un grand nombre d'autres moins complets.

ECOLOGY AND DISTRIBUTION OF FUNGI, Scripta Mycologica n° 9, 144 p., 12°, broché, 1980, Academie des Sciences d'Estonie S.S.R., Tartu Estonie, Prix. Rbl. 1,10.

Ce fascicule est intitulé en fonction des deux premiers articles qu'il comprend : *The composition and seasonal dynamics of the fungal cover on minera soils* and *Trophic groups of Estonian Agarics*, par K. Kalamees. Dans le premier travail, l'auteur relève les flores d'agaricales dans divers types de forêts et de prairies jusqu'à la tourbière et le marais et note sa composition et sa richesse spécifique à chaque écotype végétal. Dans un second article, il regroupe les Agaricales en 13 groupes trophiques, les mycorrhizogènes, les saprophytes de divers types de substrat et les parasites étant les principaux d'entre eux. Le fascicule se termine par une revision du genre *Lasiobelonium* par A. Raitviir, où l'auteur combine diverses espèces et en décrit cinq nouvelles. Texte en anglais.

THE CHEMOSYSTEMATICS OF THE LICHEN GENUS PERTUSARIA IN NORTH AMERICA NORTH OF MEXICO. par Martyn J. DIBBEN, Milwaukee Public Museum, Publications in Biology and Geology N). 5, iv + 162 p., 136 fig., 4°, broché, 1980. Milwaukee Public Museum, Milwaukee, Wi. 53233, USA. Prix $ 22,50 + postage.

L'examen de pas moins de 6800 specimens, incluant entre autres des matériaux historiques de quelques 40 herbiers reconnus, a été nécessaire à cette revue des 66 espèces North Américaines des lichens du genre *Pertusaria*. 14 espèces sont nouvelles. 33 espèces sont endémiques à l'Amérique du Nord, Du point de vue de leur distribution écologique, 60 % spnt tempérées, 35 % arctoboréales et 5 % tropicales, 40 acides organiques sont recensés chez les *Pertusaria*, L'auteur a appliqué l' analyse chromatographie sur silicagel à tous les échantillons, selon la méthode de Culberson, Sa taxonomie des espèces est avant tout basée sur la morphologie du thalle et de la fructification apothéciale, Sur cette base elle distingue deux sous-genres, *P*, sbg, *Pertusaria* et *P*.sbg, *Pionospora*, l'un à fructification amplicariale ou pertusariale, l'autre à fructification lécanorale ou sorédiale, L'analyse chimique s'avère une confirmation précieuse dans la distinction des espèces. Confrontées entre elles, les deux méthodes permettent de réduire le poids donné aux variations et de ne plus subdiviser l'espèce en une série de variétés ou de formes, La différenciation chimique jointe à la ségrégation géographique a permis cependant de confirmer des espèces proches comme distinctes. L'espèce type *Pertusaria pertusa*, eurasiatique, n'est pas reconnue en Amérique du Nord, celle qui lui a été confondue est décrite comme *P. consocians*, L'auteur a le souci d'une nomenclature correcte, Elle indique le nom du genre comme *nomen conservandum*, notant qu'il est illégitime (Art, 63), et réfère sans plus de détail - à regret - à un article futur. Ses synonymies précisent lestatut nomenclatural et sont justifiées par des commentaires, Les descriptions des espèces d'une liste détaillée des spécimens examinés et d'une distribution géographique illustrée. La technique macrophotographique appliquée laisse à désirer. Cette monographie à la fois nouvelle, précise et didactique mérite l'attention.

A PRELIMINARY POLYPORE FLORA OF EAST AFRICA, par Leif RYVARDEN & Inger JOHANSEN, 64° p., 212 fig., 8°, couverture papier, 1980, Fungiflora Ed. P.O.Box 95, Blindern, Oslo 3, Norway. Prix NKr 200.

Durant les 10 ans passés, alors qu'il publiaità intervale régulier les volumes des flores des Polyporaceae et des Corticiaceae d'Europe du Nord (revus dans Mycotaxon), le premier auteur a élaboré cette flore des Polypores d'Afrique orientale par diverses explorations de récolte et l'étude des grands herbiers européens. La flore couvre 5 familles, les Corticiaceae, Ganodermataceae, Hymenochaetaceae, Polyporaceae et Tremellaceae, 75 genres dont 4 nouveaux (*Antrodiella, Echinoporia, Navisporus* et *Pseudopiptoporus)* et 337 espèces dont 3 nouvelles. Des clés réellement dichotomiques des genres et espèces sont poposées et, évidemment (et pourquoi?) limitées aux seuls genres et espèces traitées. Les espèces sont décrites avec une attention particulière aux détails anatomiques et microscopiques, lesquels sont dessinés dans la plupart des espèces. L'habitat et la distribution géographique sont indiquées, mais sans liste des spécimens étudiés (le livre se veut être une flore et non une monographie). Imprimé en caractères dactylographiques, le texte est sans relief, peu attirant. Les nombreux espaces blancs donnent au livre une épaisseur de 35 mm qui fera rapidement céder la faible couverture de papier. Le livre est dédié à la mémoire de M.A. DONK.

SAPROPHYTIC MICROFUNGI FROM TAIWAN. PART 1 HYPHOMYCETES, by Takashi MATSUSHIMA, Matsushima Mycological Memoirs No 1, 82 p., 46 fig., 8°, paperback, May 1980. Publication Matsushima Fungus Collection, 23-19-601 Mikageyamate-2-Chome, Higashinada-ku, Kobe, Japan 658. Price: free of charge trough official request.

This is the first of a series of papers enumerating the microfungi collected in Taiwan during 1976 to 1978, by the author when he was guest as visiting senior mycologist at the Plant Pathology Division, Plant Protection Center, Taiwan. As in previous publications, the authors reports his profuse collections and cultures of the Hyphomycetes with the same wonderful ability and efficiency. His descriptions or comments on species are just what is needed, but his ful page drawings speak more than words. Not less than 250 Hyphomycetes including 21 new species and 2 new genera(*Acumispora* and *Cheiropolyschema*) are recorded, documented and 46 illustrated on the 82 pages of this issue. This is the start of a new mycological series entitled *Matsushima Mycological Memoirs*. We are sure of the succes which this series will receive through the mycological world. This series is distributed by the author's newly established institution, a very well standing fungus herbarium and culture collection, the *Matsushima Fungus Collection*.

BIBLIOGRAPHIA BOTANICA ČECHOSLOVACA 1973-1974, par A. Neuhäuslová-Novotná et D. Guthová-Jarkovská, 564 p., broché, 14x20 cm, Botanický Ustav ČSAV, Průhonice u Prahy, 1978.

Ce répertoire bibliographique donne toute la littérature botanique publiée en Tchéchoslovaquie durant la période citée, classée par matière et par auteur.

UNTERSUCHUNGEN ZUR KONSERVIERUNG DE FRUCHTKÖRPER DES SPEISEPILZES *PLEUROTUS OSTREATUS* UND DER PARTIELLEN AUTOLYSE VON PILZSELLWÄNDEN, par Helga SCHMITZ, Bibliotheca Mycologica vol. 77, 98 p. 8°, dos papier, 1980, J. Cramer ed.

Dans l'étude du mécanisme enzymatique de l'attendrissement observé lors de la conservation de carpophores dans des solutions acidulées acétique, citrique et lactique (pH 4) l'auteur met en évidence l'action de R-glucanase et chitinase spécifiques du pied et du chapeau du fruit, tandis que les S-glucanase et chitobiase du mycelium sont sans action. Thèse réalisée sous la direction du Pr. G. Eger-Hummel, Marburg.

MUSHROOMS OF IDAHO AND THE PACIFIC NORTHWEST. DISCOMYCETES, par Edmund E. TYLUTKI, 133 p., 27 fig., 80 phot., 13x21cm, 1979, University Press of Idaho, University Station Box 3367, Moscow, Idaho 83843, USA.

Ce livre est écrit pour les amateurs "enthousiastes" qui veulent dépasser les fontières des basidiomycètes et s'aventurer à récolter les morilles, helvelles, truffes et autres grandes Pezizales, Tubérales et Geoglossacées. Chaque espèce décrite est illustrée d'une photo blanc-noir. Une clé "de terrain, purement macroscopique" est proposée: mais elle est dichotomique et couvre 5 pages bien pleines... qu'il faut lire à chaque récolte? Une clé synoptique serait plus didactique et plus rapide. Cette remarque dépasse le cadre de ce livre qui est bien écrit et agréable. Pas moins de 122 espèces y sont classées et reconnaissables par les clés.

CBS COURSE OF MYCOLOGY, par W. GAMS, H.A. VEN DER AA, A.J. VANDER PLAATS-NITERINK, R.A.SAMSON, J.A. STALPERS, 2e édition, 110 p., 75 fig., in 8°, dos papier, CBS , Baarn, Nederland. 1980.

Le texte de ce cours (le édition revue dans Mycotaxon 3:558, 1976) est revu et complété de la littérature récente, sous à peu près le même volume. Les auteurs y développent les traits généraux de la morphologie des champignons, dans chaque groupe taxonomique, étayé de nombreuses figures et références. Le fascicule ne se veut pas un guide d'identification (voir von Arx, Champignons sporulant en culture pure, 3e éd. en prép.) mais une bonne introduction au règne des champignons.

A REVISION OF *CHRYSOSPORIUM* AND ALLIED GENERA, par C.A.N VAN OORSCHOT, Studies in Mycology, n° 20, 89 p., 36 fig., 3 pl., in 8°, dos papier, 1980, CBS, Baarn, Nederland. Prix Hfl 25.-.

Cette monographie donne les descriptions illustrées et les clés de *Chrysosporium* (22 espèces), *Myceliophthora* (8 espèces), *Emmonsia* (2 var.) *Zymonema* (1 esp.) *Trichosporiella* (2 esp.) *et Geomyces* (3 var.). La conidiogénèse blastique et thallique de ces champignons est décrite, ainsi que les relations avec les stades téléomorphiques appartenant aux Gymnoascaceae, Onygenaceae, Ascosphaeraceae et Sordariaceae. Cette revision est la première depuis le travail de Charmichael de 1962.

EESTI SEENTE KOONDNIMESTIK (LIST OF ESTONIAN FUNGI, WITH HOST INDEX AND BIBLIOGRAPHY) par J. JÄRVA et E. PARMASTO, 331 p., Din, dos papier, 1980, Institute of Zoology and Botany, Academy of Sciences of the Estonian S. S. R, Tartu, Estonia, Prix: Rbl. 2,10.-

Cette liste des champignons de l'Estonie est le résultat de 15 ans de travail des mycologues de l'Académie de Tartu pour le dépouillement de 1200 publications citées en annexe. Chaque espèce est citées avec hôtes et références.

BIOLOGY IN THR BLUE RIDGE, Fifty Years of the Highlands Biological Station, 1927-1977, by Ralph M. SARGENT, 156 p., ill., 8°, paperback, 1977, Highlanus Biological Station, P.O.Drawer 850, Highlands N.C. 28741.

The then named Highlands Museum and Biological Laboratory, initiated in 1927 by a few determined people eager to preserve local human and natural history,has been, from the early years, associated with mycology. The Highlands station, in 1934, received the Mycological Society of America for its summer foray. Dr. William Chambers Coker, who presided the institution from 1933 to 1943,and subsequently as Honorary President, has been, with Dr L.R. Hesler, Vice-President, the promotors of the study of the Appalachian fungi. Coker published on basidiomycetes, particularly *Hydnum* and the Boletaceae (1939-1951). Hesler continued his *Notes on Southern Appalachian Fungi* in Mycologia from 1936 to 1955, and collaborated with Alexander H. Smith on *Hygrophorus* and *Lactarius* (1932-1962). Dr. L.S. Olive (1943-1953) published on Tremellales and in 1965 his book *Poisonous, Edible and Hallucinogenic Mushrooms*. Dr. Ronald H. Petersen, more recently investigated the clavaroid fungi and the aquatic hyphomycetes (1962-1963). Surely, the Blue Ridge Laboratory contributed much in 50 years to the American mycology. The Sargent's book, retracing, years after years, the multiple ways and reviving the unique spirit of the Highlands Biological Station will please the present and the future scientific people.

PHYTOPHTHORA CINNAMOMI AND THE DISEASE IT CAUSES, by G. A. ZENTMYER, Monograph No 10, 96 p., 39 figs., 4°, paperpack,1980, The American Phytopathological Society, 3340 Pilot Knob Road, St Paul MN 55121. Price US $ 8.-.

How is it possible to cover such widespread and largely investigated fungus pathogen like *Phytophthora cinnamomi* in 95 pages. The author did, and on the base of 600 literature references. The pathogen is of importance for the decay of many tropical and temperate crops and trees. 900 hosts have been listed. The monograph details the many aspects of the biology, ecology, physiology and genetics of the pathogen, all data necessary in the search to an effective control. The text is dense and illustrated of many original documents. George A. Zentmyer of the University of California, Department of Plant Pathology is devoting himself on the study of that pathogen for already 20 years and published with his collaborators more than 100 papers on the subject. His mastership in that field will help many people engaged in research through the world.

A MANUAL OF ASSESSMENT KEYS FOR PLANT DISEASE, by Clive JAMES, 44 fiches illustrées, 10x18 cm., 1980, The American Phytopathological Society , St Paul. Prix US $ 10.0.

Ces fiches illustrent les clés d'évaluation des dégâts par *Rhynchosporium, Puccinia, Septoria, Drechslera* sur céréales,*Phoma, Leptotrochila Stemphylium* sur luzerne et trèfle, *Phytophthora, Streptomyces, Rhizocto-*

nia sur pomme de terre et *Xanthomonas* sur haricot. Elles aideront les phytopathologistes à effectuer des évaluations comparables.

LABORATORY HANDBOOK OF MEDICAL MYCOLOGY by Michael R. McGINNIS, 662 p., ill., 8°, hard cover, 1980. Academic Press, N.Y.

"Owing to the increased importance of fungi in medecine, there is a pressing need to discuss important topics such as laboratory safety and emergency procedures, quality control and modern concepts,... to assist microbiologists in safety isolating and acurately identifying fungi of medical importance.... The key to understanding any field of science necessitates a thorought understanding of its language..." (the author). Thus, the author devotes its first chapter to the morphological terms to be use in modern medical mycology for the description and the classification of the fungi, while chapter 4 (233 p.) and chapter 5 (63 p.) describe the systems of classification, detail the methods of study and comment the diagnoses of genera of, respectively the Ascomycetes, Coelomycetes, Hyphomycetes and Zygomycetes (sic) in the former and the yeasts in the later. Chapter 9 (50 p.) adds a synopsis of the mycoses, describing and illustrating symptoms, etiology and therapeutics of each disease. The other chapters of the book are descriptive of technics: laboratory safety, handling clinical specimens, bioessay procedures, susceptibility testing, quality control, equipment maintenance, culture collection and culture media. Appendices provides with glossary, list of synonyms and list of fungal records on man.

The book is no doubt interesting and useful, not only for the techniques described, but as an effort of providing medical mycologists with the developments in modern descriptive mycology, especially in the field of the Hyphomycetes, after the First Kananaskis Conference of 1969.

Non obstant such evident value, the book presents several major defects that myself at least, I do regret. In the general disposition of the contents, the book might have been divided advantageously into two parts, one part, taxonomic, including chapters 1, 4 and 5 (the techniques excluded), chapter 9 and the appendices, the other part, technical, grouping chapters 2 and 3 with chapters 6 to 10, and the culture methods from chapters 4 and 5. That grouping might have avoided regrettable duplications between chapter 1 and chapter 4 in text and illustration.

The illustration is, beside a few line drawings, essentialy made of black and white microphotographs of fungi, 11 x 8.5 cm (half page) in size, many of them being of good quality. Unfortunately, the illustration is defective in several ways. The magnification is not given. The numbering of the photographs, composed of the chapter number and the figure number within the chapter is complex and unconvenient to the reader. Furthermore from a count of 219 numbered figures, 52 are composed of 2 or 3 separate full-size photographs, not mounted in plate, but printed on distinct pages most often and provided with a full legend under fig. -A which is said "continued" under fig. -B and fig. -C. This constitutes another unconvenience. The procedure is in most case unjustified. Either the photographs composing a figure show the same fungus at low and high magnification, the one at low magnification being generally of no use or no value; or the photographs represent different fungi and could have been numbered and legended separately. At the same, the duplication of the same or similar pictures of the same fungus, illustrating here a term and further a generic concept might have been avoided. For instance, a picture of *Drechslera sp.* fig. 1.1 is the inverted photograph fig. 4.46 of the same. Why *Trichothecium roseum* needs to be shown at different focusing in figures 4.105A and 4.105B on p. 303 and 304? Why *Syncephalastrum ramosum* must appear in 5 figures (1.9A, 1.9B, 4.120A, 4.120B, 4.121) and on distinct pages? Unacceptable is the fact that *Exophiala spinifera* is not only figured three times in figs.1.27, 4.13 and 4.50 but also duplicated in fig. 4.49A, identical to fig. 4.13, under the name *Exophiala jeanselmei*. It will be also mentioned that amongst the 161 figs. illustrating chapters 1 and 4, 50 figs. are of unidentified species of filamentous fungi. Why, in such an handbook designed to be informative as much as examplative, the author choose to illustrate unidentified isolates rather than properly identified fungal species of medical importance which are available in pure culture in official culture collections? Why finally the photographs are supplemented of such poor and inacurate line drawings?

Other defects are in the text. The author decided not to cite the authors of the names of the fungi in the text, but did cite them, in Appendic C, only for the correct names of which he listed a synonym but not for many other names used in the text. The reader will have to consult other sources to distinguish for instance *Blastomyces dermatitidis (*conidial *Ajellomyces dermatitidis)* from *Wangiella (Hormiscium, Phialophora, Exophiala) dermatitidis.*

At the exception of the references inserted in the comments following the generic descriptions of the fungi, references to the literature are totaly absent from the general text, like are the references to published sources for the 77 culture media cited. The reader need to be informed on the source of every statement, term, definition, classification, key, technique or formula other than the author's personal ones.

Dealing with terminology in chapter 1, the author restrict the application of the term *chlamydospore* to those terminal inflated thick-walled cells which are able to germinate and be reproductive and proposes the use of the term *vesicle* for the not germinating terminal chlamydospores as well for the intercallary ones. This proposition should be disrecommanded, the term *vesicle* being currently designating the ampulliform tip of the *Aspergillus* conidiophore stipe. Further the author illustrates the term *favic chandelier*, in use in medical mycology, by a photograph of the appressorial hyphae in *Botrytis cinerea.* As soon as 1870, J. KLEIN introduced the term *appressorium* to designate that type of hypha differentiated for the attachment of the fungus. There is no reason for abandoning that term.

A final remark is needed to infirm the author's statement "flagellate cells are produced only by the chytrids" on page 1 to 2.

Published by Academic Press, this handbook takes benefit of a high quality typographic printing and binding, as it will surely be in the hands of many mycologists in medical centers and laboratories.

FUNGAL BIOTECHNOLOGY, by J.E. SMITH, D.R. BERRY & B. KRISTIANSEN, x + 308 p., ill., 8°, hard cover, 1980. The British Mycological Society, Symposium series n° 3. Academic Press, 111 Fifth Avenue, New York, NY10003. Price $ 32.50.

This book is the proceedings of a joint symposium of the British Mycological Society and the Society of Chemical Insdustry, held in Glascow in September 1978. The recent developments of the fungal biotechnology has incited more research on the uses of fungi in the industrial processes. The book is a selection of topics related to the inoculation the growth and the exploitation of the fungi through the operation of liquid and solid state fermenters. The parameters of fungal growth, from the preparation of the inoculum, the genetical hazards, the rheological conditions to the reactions to the type of fermenter and the nature of the developed particles, are largely investigated and discussed for their interference in the design of the fermenters. The production of edible fungi is also considered. The potentialities of fungal biotechnology are reviewed and the achievements in different regions of the world also described. Although the repeated orthographic errors in the names of the fungi, this book remains a very interesting account to applied mycology.

FUNGAL SAPROPHYTISM by Harry J. HUDSON, Studies in Biology n° 32, 2d ed., 76 p., ill., paper back, 1980. Edward Arnold Publ. , 41 Bedford Square, London WC1B 3DQ. Price £ 2.25.

It is good to realize the author's ability to reach so many goals through these modest 70 pages: enhancing curiosity and interest for the fungi, considering many aspects of the fungal ecology, guiding the student on the field and in the laboratory and demonstrating the practical interest of the fungi in industry and human life. Some titles: wood decay, blue stain, basidiomycetes and microfungi in litter, chitinolytic fungi, lignine decomposition, pyrophilous fungi, coprophilous fungi, moisture requirements, osmophilous fungi, storage fungi, xerophytes, aquatic fungi, water pollution, thermophilous fungi, composts, fermented foods, antibiotics, vitamins. An exciting introduction to mycology, through ecology.

FUNGI, MAN AND HIS ENVIRONMENT, by R.C. COOKE, 144 p., ill., paper back, 1977. Longman Group Ltd, London. Price £ 3.5.

"I have attempted to write a book about fungi rather than a textbook on fungi". The author indeed realizes a similar approach to that of Houston, but with many more information and considering also the parasitic fungi, appealing the awareness of people on the danger and value of the fungi in the present and future world. From the pests and mycoses to their control, from the degadation of organic matter to the synthesis of protein and the cultivation of mushrooms for foods and drugs, the author clearly demonstrates the multiple both destructive and elaborative potentialities of the fungi, in which, finally, man is concerned. With science and philosophy, he suscites the desire of reading more on fungi.

DIE BLÄTTERPILZE (AGARICACEAE) DEUTSCHLANDS UND DER ANGRENZENDEN LÄNDER BESONDERS OESTERREICHS UND DER SCHWEIZ, par Adalbert RICKEN xxiv + 482 p., 122 pl. col., in 8°, relié, Leipzig 1915. Réimprimé par Dr. Massimo CANDUSSO, Viale Europa 5, 21047 Saronno (Varese) Italia. Disponible dans l'allemand original (Lit. 98,000.- net) ou traduit en italien par Dr. Lazzari (Lit. 82,000.- net).

La réimpression de l'oeuvre mycologique originale et unique de Adabert RICKEN (1851-1921) est un événement heureux. Publiée et distribuée par livraisons successives de 32 pages et 8 planches colorées de 1910 à 1915, l'oeuvre de RICKEN fut très bien accueillie par le monde mycologique de l'époque d'après guerre . En effet l'oeuvre est le bilan de quarante année de récoltes mycologiques (1870-1910) en Allemagne et régions limitrophes et portant sur plus de 1500 espèces. L'ouvrage présente dans un ordre systématique la description de 14£2 espèces d'acarics sur la base d'observations précises tant microscopiques que macroscopiques, avec mention de l'habitat et, pour 662 espèces, une illustration

en couleurs reproduisant les peintures à l'huile que réalisa l'auteur sur le frais. La nomenclature est traditionelle mais étayée des dates de publication. La dernière livraison comporta outre l'introduction et les index alphabétiques trois clés dichotomiques des genres, fort bien construites et basées sur les caractères les plus évidents.

La réimpression entreprise par l'Imprimeur mycologue, Dr. Massimo CANDUSSO est particulièrement réussie. Le texte est reproduit de manière régulière sur du papier de qualité. Les planches en couleurs, éditées sur un carton plus fort comme les originales, reproduisent les tons les plus stables des différents exemplaires originaux comparés. La reliure de type ancien est préservée dans une gaine. La qualité de cette réimpression mérite les encouragements du plus grands nombre de mycologues.

ICONOGRAPHIA MYCOLOGICA par Giacomo BRESADOLA, avec J.B. Traverso, L. Fenaroli, G. Catoni & J.B. Trener editeurs, 26 vols. 156 p., 1250 pl. col., Milan 1927-1933. Réimpression par Dr. Massimo CANDUSSO, Gruppo Micologico G. Bresadola, Viale Europa 5, 21047 Saronno (Varese) Italia, in 5 vols., 1250 pl. col., relié, Sept. 1981-Déc. 1982. Prix souscription Lit. 100.000 before September 1981, Lit. 100.000 au reçu des vols. 1, 2 and 3, le solde Lit. 60-85.000 au reçu du 4e vol.

L'examen de la planche proposée par l'imprimeur CANDUSSO au souscripteur semble présenter toutes les garanties de qualité que l'on peut espérer, voire exiger, d'une telle réimpression. L'ouvrage de Bresadola est une oeuvre majeure dans la connaissance des champignons. La réimpression ne sera réalisée que si la souscription est suffisante. On ne peut que recommander aux mycologues et aux institutions de science mycologique l'acquisition d'un ouvrage que les générations futures de mycologues à travers le monde ne pourront ne pas connaître ni ne pas consulter.

Also received:

LABORATORY GUIDE FOR IDENTIFICATION OF PLANT PATHOGENIC BACTERIA par N.W. SCHAAD, 72 p. 4 pl. col., mimeographed, 4° in folder, 1980. The American Phytopathological Society, St Paul, USA. Prix US $10.-

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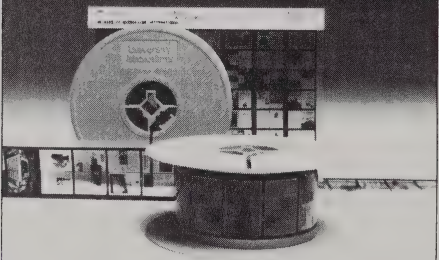

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THE GENUS PILOPHORUS

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Summary

All species of *Pilophorus* are examined and four species are excluded from the genus. The remaining 10 species are described and their geographical distribution is demonstrated on maps. Characteristics used for the separation of species are discussed and an artificial key is given.

Introduction

Formerly the genus *Pilophorus* was placed in the Cladoniaceae (Zahlbruckner, 1926), while today the genus is thought to be related to the genus *Stereocaulon* (Jahns, 1970a; Henssen and Jahns, 1973). In an earlier paper I attempted to delimit some species within the genus (Jahns, 1970b), but the choice of the species investigated at that time was arbitrary, resulting from the context of my ontogenetic work, so that no claim for completeness could be made. Furthermore, the investigations of most species were based on relatively limited material, so that conclusions about variation of characteristics and geographical distribution were not reliable. For these reasons it seemed desirable to complete the earlier observations and to extend the work to all species described by other authors and at the same time to include more specimens. This is the aim of the present work. Most of the specimens available from the major herbaria were used in this investigation (more than 1000 specimens). A complete list of their geographical distribution is not included as it would ask to much space. For all practical purposes it seemed to be sufficient to characterize the occurring species, to mention their most important synonyms, to distinguish them from each other and to demonstrate their distribution on maps. The exact places of origin are given for specimens found outside the main area of distribution. For a complete list of literature and synonyms see Zahlbruckner (1927b, 1939).

Material and methods

The material investigated was received on loan from the following herbaria: Herbarium University of Michigan, Ann Arbor (MICH); Herbarium of the University of Georgia, Athens (GA); University of Texas Herbarium, Austin (TEX); Universitetets Botaniske Museum, Bergen (BG); Herbarium University of California, Berkeley (UC); Botanisches

Museum, Berlin (B); Botanisches Institut, Bern (BERN); Museum of Natural History, Budapest (BP); Farlow Herbarium of Cryptogamic Botany, Harvard University, Cambridge (FH); Commonwealth Scientific & Industrial Research Organization, Division of Plant Industry, Canberra (CANB); Chicago Natural History Museum, Chicago (F); University of Alaska, College (ALA); Botanical Museum and Herbarium, Copenhagen (C); National Botanic Gardens, Dublin (DUB); Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt (FR); Conservatoire et Jardin botaniques, Geneva (G); Botaniska Trädgard, Göteborg (GB); Department of Botany, Dalhousie University, Halifax (DAL); Botanical Museum, Helsinki (H); Botanical Institute of Hiroshima University, Hiroshima (HIRI); Botanisches Institut der Universität, Kiel (KIEL); Rijksherbarium, Leiden (L); Herbarium of the Department of Systematics and Plant Geography of the Botanical Institute of the Academy of Sciences of the USSR, Leningrad (LE); Institute of Botany, Faculty of Science, Lisboa (LISU); British Museum, Natural History, London (BM); Botanical Museum and Herbarium, Lund (LD); Herbarium of the University of Wisconsin, Madison (WIS); Botanisches Institut, Marburg (MB); Herbarium A. Henssen, Marburg (Hsn); Botanische Staatssammlung, München (M); Herbarium of Yale University, Osborn Botanical Laboratory, New Haven (YU); New York Botanical Garden, New York (NY); Hattori Botanical Laboratory, Nichinan (NICH); Botanisk Museum, Oslo (O); National Museum of Canada, Natural History Branch, Ottawa (CAN); Oulun Museo, Oulu (OULU); Orto Botanico, Padova (PAD); Muséum National d'istoire Naturelle, Laboratoire de Cryptogamie, Paris (PC); Botanical Department of the National Museum, Praha (PR); Division of Botany, National Herbarium, Pretoria (PRE); University of Washington, Herbarium, Botany Department, Seattle (WZU); Botanical Department, Naturhistoriska Riksmuseum, Stockholm (S); Botanical Department of Tromsoe Museum, Tromsoe (TROM); Botanical Department, Museum of the Royal Norwegian Society for Science and Letters, Trondheim (TRH); Botanical Institute of the University, Turku (TUR); Institute of Systematic Botany, University of Uppsala, Uppsala (UPS); US National Museum, Department of Botany, Washington (US); Naturhistorisches Museum, Wien (W); Botanischer Garten und Museum der Universität, Zürich (Z).

The specimens were mainly investigated with a stereo-microscope and some typical material was cut with a freeze-microtome.

The genus Pilophorus and its subdivision

In my earlier Work I explained in detail why in my opinion the correct name of the genus and the correct epithet are "*Pilophorus* Th.Fr.". Further discussion of this question followed from Culberson (1970), who favored the name "*Pilophoron* (Tuck.)Th.Fr." and from Hawksworth, James and Laundon (1972), who agreed with my interpretation. Closely related to this problem is the question of the type species, which in my opinion should remain *P. robustus* Th.Fr. (Jahns, 1970b).

In the last hundred years not only has the number of species subsummized under this genus fluctuated considerably, but attempts have also been made to subdivide the genus. An extreme proposal was the classification of Tuckerman (1882) who considered *P. cereolus* to be the only species of the genus - designating all other species earlier described as subspecies of *P. cereolus*.

Stitzenberger (1862) included the genus *Helocarpon* Th.Fr.

as a subgenus in the genus *Pilophorus.* He referred implicitly to the description of Th. Fries (1861), who mentions for *Helocarpon crassipes* short black, stalked fruitbodies. Fries himself obviously did not consider a relation between the two genera described - *Pilophorus* and *Helocarpon* - but later declared *Helocarpon* to be a synonym for *Lecidea* (Th. Fries, 1874). Having examined the type material of *Lecidea crassipes,* I can confirm that there is no anatomical or morphological similarity with any species of *Pilophorus.*

A different subdivision of the genus was proposed by Satô (1940). When giving the description of the new species *P. nigricaule* he believed there were principal differences between this species and all other representatives of the genus. He therefore suggested a division of the genus into a section *Nigricaule,* including *P. nigricaule,* and a section *Eupilophorus,* including all remaining species. It was explained earlier (Jahns, 1970a) that this subdivision cannot be accepted, as Satô based his description of the new section on a far too rigid partition of tissues and on pigmentation of the stalk tissue which, with variable intensity, can be found in other species too.

On the whole there seems to be no justification for any subdivision of the genus.

The importance of different characteristics for the separation of species

For the separation of the species the same criteria were used as described in the first paper dealing with part of the genus (Jahns, 1970b). However, it is now possible to give a more accurate definition of the range of variation and to judge the value of the different characteristics more rigidly.

Thallus horizontalis

The thallus horizontalis is always crustose and is generally grey or grey-green in color when dry. It consists of minute granules (fig. 1-3) or of flat or inflated scales (fig. 8). Small granules or scales may be pressed together, forming distinct areolae (fig. 7). In some species, especially in older material, the thallus horizontalis may be almost absent. The shape of the horizontal thallus is clearly specific and relatively constant for each species. Therefore it may be used as a distinguishing characteristic, but on its own it is not sufficient for the separation of the species. Principally the external morphology may be characteristic for each species but a certain degree of variation in shape is induced by factors like substrate, etc. Thus intermediate forms and transitions between the habits of different species may occur. Furthermore, variations in shape of the horizontal thallus among different species are difficult to explain, so that this characteristic is of restricted value for use in artificial keys.

Thallus verticalis and growth form

The thallus verticalis of *Pilophorus* is a pseudopodetium similar to the one found in the genus *Stereocaulon.* The position of the apothecia is always terminal. The pseudopodetia may be simple or branched. Their size varies within certain limits but offers a useful aid for the description of the species. In nearly all species a few fertile specimens occur where pseudopodetia are absent and the apothecia are sessile on the thallus horizontalis. The habit of the pseudopodetia offers one of the best means of distinction for taxonomic use. Most common are simple, unbranched and pin-shaped pseudopodetia, which occur in *P. cereolus, P. strumaticus, P. nigricaule, P. fibula* and *P. curtulum* (fig. 3,6, 7,8,10). If the pseudopodetia of these species bear more than one fruitbody, an indistinct terminal branching may be simulated. In contrast to these pin-shaped species, *P. robustus* and *P. acicularis* have high, branched pseudopodetia which grow in dense clusters (fig. 1,9). An intermediate growth form between these two types is represented by *P. vegae, P. awasthianum* and *P. clavatus.* Their pseudopodetia are of middle height and somewhat branched and, at least in *P. vegae* and *P. awasthianum,* may grow in more or less distinct clusters (fig. 2,11). Quite typical for all species is their manner of branching, which is umbellate in *P. robustus* (fig.9), and forked in *P. acicularis, P. vegae* and *P. awasthianum.*

The pseudopodetia are usually covered with an algal layer which is not continuous and often resembles the granules and areolae of the thallus horizontalis. Older stalks may be partially bare. In *P. nigricaule* the stalk is covered with conspicuous peltate scales, which are closely pressed together (fig. 8,17).

Soredia

In all species of *Pilophorus* the pseudopodetia are covered with an algal layer which is never continuous but composed of more or less dispersed areolae. A true cortex is only poorly developed and usually completely absent, so that the pseudopodetia in some species have a granular appearance. True soredia only occur in *P. cereolus,* where they give a distinct powdery look to the stalk (fig. 3).

Cephalodia

Cephalodia are characteristic for all species of the genus *Pilophorus.* However, two species which have been included in this genus (*P. conglomeratum* and *P. staufferi*) lack cephalodia. This, among other reasons, justifies in my opinion the exclusion of these species from the genus *Pilophorus.*

The cephalodia of *Pilophorus* are sacculate and exhibit no special wall structure. In the three tallest species, *P. robustus, P. acicularis* and *P. vegae,* some cephalodia occur on the pseudopodetia (fig. 1,9,11), but in all other species they are only to be found on the thallus horizontalis. Their shape is irregular, the surface smooth or granular, and they are light brown to deep brown-black in color.

The cephalodia either contain algae of the *Nostoc* or of the *Stigonema* type. In the species investigated I found *Stigonema* in *P. strumaticus, P. fibula, P. curtulum* and *P. nigricaule,* while in *P. robustus* and *P. awasthianum* I found only *Nostoc.* In *P. acicularis* I observed only *Nostoc,* but Kurokawa and Shibuichi (1970) found *Stigonema* in this species. This contradiction may not result from a misobservation, because in *P. cereolus, P. clavatus* and *P. vegae* I found some cephalodia with *Stigonema* while others contained *Nostoc* . However, in general, all cephalodia of one specimen contain the same alga. Exceptions are rare. Cephalodia of *P. vegae* contain *Nostoc* and *Stigonema* and possibly algae of the *Gloeocapsa* type as well.

Nostoc bearing cephalodia often have a habit distinct from those with *Stigonema.* They are always characterized by a smooth surface, while cephalodia with *Stigonema* as phycobionts show a granular surface, at least in their younger stages of development. This phenomenon is explained by the development of the cephalodium which was described elsewhere (Jahns, 1972).

It is not impossible that from those species which seem to contain only one algal species in their cephalodia, specimens with other phycobionts will be found in the future. The occurrence of specific blue-green algae in the cephalodia is therefore not a useful taxonomic characteristic.

Pycnidia, ascospores, fruitbody development

Pycnidia occur abundantly in all species of the genus *Pilophorus.* They are either located on sterile pseudopodetia or on the thallus horizontalis. The conidiophores are unbranched and the conidia sickle-shaped. The size of the conidia does not differ significantly in the different species, so that this characteristic is unimportant for the taxonomy of the genus. The same holds for the ellipsoid ascospores.

The development of the fruitbodies is very uniform too (Jahns, 1970a). Some specimens of *P. clavatus* form an exception. Numerous young apothecial primordia are located in bundles on short stalks (fig. 4). In the further course of development the primordia fuse and, with the growth of the generative tissue, form the typical elongated fruitbody of the species (fig. 5,16).

Anatomy and morphology of the apothecium

The outer shape and inner structure of the apothecium belong to the best characteristics for the separation of the species. In most species the mature apothecia are almost globose and quite often several apothecia are laterally fused (fig. 1,9,10). An exception is the fruitbody of *P. clavatus,* where the hymenium extends a considerable distance down the pseudopodetial stalk so that the apothecium assumes a triangular outline in longitudinal section (fig. 5,16). Smaller variations of the spherical structure are found in *P. awasthianum* and *P. nigricaule,* which both tend towards slightly triangular-shaped fruitbodies (fig. 2,8).

However, it is possible that the samples of *P. awasthianum* that I examined were not fully developed and mature.

A longitudinal section reveals that the spherical shape of the apothecia is not uniformly formed. Apart from true globose apothecia, fruitbodies may be flattened with a margin of the hymenium that may hang down for a considerable distance before curving upwards again to fuse with the stalk (fig. 14).

Anatomically, three major characteristics are of importance: the boundary-texture, the pigment-boundary and the columella. The boundary between the vegetative tissue and the generative tissue of the fruitbody, which is always easily recognized, may follow different patterns. It forms a thin horizontal zone in the lower periphery of the fruitbody in most species (fig. 14), whereas in *P. robustus* and *P. strumaticus* the vegetative tissue extends upwards into the generative tissue of the apothecium (fig. 12) forming a cone-like columella.

The boundary between the vegetative and generative tissues may be emphasized by two conspicuous structures. In the transition zone the generative tissue may form a boundary-texture built from closely interwoven, short-celled hyphae (fig. 13). Often the junction of vegetative and generative tissue is characterized by a deposit of black-brown pigment (fig. 15), which is referred to as the pigment-boundary. The pigment-boundary bears little relationship to the boundary texture and may or may not be superimposed. Black pigment is often concentrated in the subhymenial layers (fig. 14,15) as well as in the pseudopodetial tissue (for example in *P. nigricaule*, *P. vegae* and *P. strumaticus*).

The columella, the boundary-texture and the pigment-boundary are characteristics which help to separate the species very accurately. These characteristics may occur singly or combined.

Secondary products

Small amounts of several specimens were investigated by TLC. The results obtained agree in general with those published by Krog (1968) and Kurokawa and Shibuichi (1970). All species contain atranorin and zeorin. Stictic acid was found in *P. nigricaule* and *P. vegae*. Furthermore, Kurokawa and Shibuichi found caperatic acid in *P. clavatus* and constictic acid in *P. nigricaule* as well as six other non-identified substances in different species of the genus. These observations could not be substantiated in detail.

In this study the chemical characteristics will not be considered for taxonomy, as obviously only those substances that are common to all species occur in sufficient amounts. In order to avoid seriously damaging the usually limited material of the herbarial specimens it is sometimes impossible to demonstrate the presence even of atranorin and zeorin. Therefore, it is almost impossible to obtain an exact and reliable picture of the distribution of these substances with the methods described.

Substrate

The species of this genus grow exclusively on silicate stone. As an exception single colonies may extend to rigidly pressed soil covering the stone. One specimen of *P. acicularis* from USA, Washington (near Lake Cushman, Mason Co., S.East Olympias (F)) was found growing on dead wood. The numerous other specimens from the same region suggest extremely favorable climatic conditions which enable the lichen to colonize the unfamiliar substrate.

Distribution

The species of the genus *Pilophorus* occur exclusively in the northern hemisphere. *P. conglomeratum, P. colensoi* and *P. staufferi* described from Australia, New Zealand and New Caledonia are no longer included in the genus *Pilophorus*. In the literature it is still maintained that *P. acicularis* occurs in Australia and Africa (Cape of Good Hope). These statements refer exclusively to a note from Nylander (1860) who claims to have seen the material in the Hooker herbarium, but these specimens disappeared later. In the year 1860 the separation of the species was not well defined, so that it may well have been *P. conglomeratum*. In any case I consider this information too doubtful to include in the distribution maps.

The distribution maps of the individual species are based almost exclusively on specimens which I have personally investigated. Only in a few cases have I included notes from other workers (Krog, 1968; Ammann and Ammann, 1969; Kurokawa and Shibuichi, 1970), as I am certain that the definition of species by these authors agrees with my own views.

The individual points in the distribution maps often include material from a relatively large area. The number of specimens examined is given for each point. However, in many cases these numbers are almost certainly slightly higher than the number of findings proper, as it was impossible always to recognize identical specimens from the same gathering which had been distributed and preserved in different herbaria. In those cases where a single finding is represented by numerous specimens distributed as an exsiccate it is only recorded as a single point. The exact places of origion are indicated in detail only when either very few such places are known or when those places are outside the main area of distribution. Places which are listed in the description of the species are marked by a point, others not individually listed are marked by a square on the maps. Findings taken from other authors are marked by a triangle.

In general the following large-scale distribution was established: One group of species (*P. acicularis, P. nigricaule, P. clavatus*) occurs around the northern Pacific Ocean. In the same area two more species are found which, however, are restricted to only part of this area (*P. curtulum* in China and Japan, *P. vegae* in Alaska and the Bering Strait area). One species (*P. awasthianum*) is restricted to the Himalayas and another (*P. fibula*) to the eastern parts of the USA. One species (*P. strumaticus*) occurs only in those parts of Europe which have an oceanic climate. Very typical is the distribution of *P. robustus*, which is found circumpolarly in the most northern areas and in high mountains. *P. cereolus* shows the most irregular distribution. This species is most abundant in Scandinavia but occurs in single specimens in middle and central Europe, in Siberia and in the eastern part of North America.

Artificial key to the species

1a Lichen with pseudopodetia and developed apothecia 2

1b Lichen without pseudopodetia or pseudopodetia without apothecia, sometimes with pycnidia or black primordia of apothecia. 15

2a Thallus horizontalis and pseudopodetia clearly sorediate. Pseudopodetia pin-shaped, unbranched, at most 1 cm high. Apothecia without columella (fig. 3). *P. cereolus*

2b Surface not sorediate, at the most slightly granulose. 3

3a Pseudopodetia with continuous white cortex. Ecorticate parts of the pseudopodetia and their central part always black. Pseudopodetia 0.5-1.5 cm high, usually dichotomously branched. Large cephalodia on short branches. Apothecia unknown. Alaska, Bering Strait. (fig. 11) *P. vegae*

3b Lichen with other characteristics. 4

4a Pseudopodetia smaller than 5 mm. 5

4b Pseudopodetia higher than 5 mm. 11

5a Apothecia cylindrical or triangular in longitudinal section, at least twice as high as broad (fig. 16). Pseudopodetia pin-shaped, unbranched. Apothecia often slightly bifurcate at the apices (fig. 5). *P. clavatus*

5b Apothecia globose, sometimes several globose apothecia are fused. 6

6a Pseudopodetia very thin (0.2-1.0 mm broad, 5 mm high), more or less branched, partly ecorticate and black (fig. 2). Himalayas. *P. awasthianum*

6b Pseudopodetia broader, pin-shaped, unbranched. 7

7a Scales of the thallus horizontalis and of the pseudopodetial cortex peltate (fig. 17), white, pressed together, with an inflated appearance. Inner parts of the pseudopodetium with dark pigment. Apothecia with boundary-texture, globose or sometimes pointed (fig. 8). *P. nigricaule*

7b Lichen with other characteristics. 8

8a Thallus horizontalis formed by granules or minute scales. Granules or scales fused into broader, closely arranged areolae (fig. 6,7). 9

8b Granules or scales of the thallus horizontalis scattered. 10

9a Apothecia always with boundary-texture and pigment-boundary. Pseudopodetia usually not higher than 1 mm (at most 2 mm) (fig. 7). Eastern North America. *P. fibula*

9b Apothecia always with boundary-texture, only very old specimens with pigment-boundary. Pseudopodetia 1-3 mm high (fig. 6). Japan and China. *P. curtulum*

10a Apothecia without columella, with boundary-texture and in old specimens with pigment-boundary (fig. 6). Japan and China. *P. curtulum*

10b Apothecia with columella, without boundary-texture and pigment-boundary (fig. 10,12). Europe. *P. strumaticus*
11a Apothecia cylindrical or triangular in longitudinal section, at least twice as high as broad (fig. 16). Pseudopodetia pin-shaped, unbranched. Apothecia often slightly bifurcate at the apices (fig. 5). *P. clavatus*
11b Lichen with other characteristics. 12
12a Scales of the thallus horizontalis and of the pseudopodetial cortex peltate (fig. 17), white, pressed together, with an inflated appearance. Inner parts of the pseudopodetium with dark pigment. Apothecia with boundary- texture, globose or sometimes pointed (fig. 8). *P. nigricaule*
12b Lichen with other characteristics. 13
13a Pseudopodetia very thin (0.2-1.0 mm broad, 5-15 mm high), more or less branched, partly ecorticate and black (fig. 2). Himalayas. *P. awasthianum*
13b Lichen with other characteristics. 14
14a Pseudopodetia umbellately branched towards the apices. Apothecia numerous, often fused at the margins, with large columella (fig. 9,12). *P. robustus*
14b Pseudopodetia dichotomously branched, in combed tufts, smaller plants unbranched. Apothecia without columella (fig. 1). *P. acicularis*
15a Pseudopodetia with pycnidia or with primordia of apothecia present. 16
15b Only thallus horizontalis present. 21
16a Thallus horizontalis and pseudopodetia sorediate. Pseudopodetia pin-like, often broadest in the middle (fig. 3). *P. cereolus*
16b Lichen not sorediate. 17
17a Pseudopodetia very thin (0.2-1.0 mm broad, 5-15 mm high), more or less branched, partly ecorticate and black (fig. 2). Himalayas. *P. awasthianum*
17b Pseudopodetia broader. 18
18a Pseudopodetia with continuous white cortex. Ecorticate parts of the pseudopodetia and their central part always black. Pseudopodetia 0.5-1.5 cm high, usually dichotomously branched. Large cephalodia on short branches. Apothecia unknown (fig. 11). Alaska, Bering Strait. *P. vegae*
18b Lichen with other characteristics. 19
19a Thallus horizontalis persistent, formed by closely connected areolae. Sterile pseudopodetia 1-2 mm high, terminated by a pointed pycnidia. *P. clavatus*
19b Thallus horizontalis formed by scattered granules, evanescent in older specimens. 20
20a Pseudopodetia at least indistinctly umbellately branched in their upper part. With numerous pycnidia or primordia of apothecia. *P. robustus*
20b Pseudopodetia slender, unbranched or dichotomously branched. *P. acicularis*
21a Thallus horizontalis not sorediate, sometimes granular. 22
21b Thallus horizontalis sorediate. *P. cereolus*
22a Thallus horizontalis formed by white, peltate, inflated scales or granules. Japan, west coast of North America. *P. nigricaule*
22b Lichen with other characteristics. 23

23a Thallus horizontalis persistent, formed by closely connected areolae. 24
23b Thallus horizontalis persistent or evanescent, formed by more or less scattered granules or scales. Determination only from distribution (see maps). *P. robustus, P. strumaticus, P. acicularis, P. vegae, P. awasthianum, P. curtulum*
24a Areolae thin, not distinctly formed by individual granules. *P. clavatus*
24b Areolae thick, composed of small granules. 25
25a Distribution in Japan and China. *P. curtulum*
25b Distribution in the eastern North America. *P. fibula*

Description of the species

Pilophorus acicularis (Ach.) Th.Fr., De *Stereocaulis* et *Pilophoris* Comm.: 41 (1857).
Baeomyces acicularis Ach., Meth. Lich.: 328 (1803). Type collection: North America, Hall (UPS, isotype).
Cenomyce acicularis Ach., Lich. Univ.: 567 (1810).

Thallus horizontalis small granular, evanescent in older thalli, grey when dry. Pseudopodetia (0.5-) 3 cm high, 1 mm diameter. Mostly simple or dichotomously branched, stalks curved so as to appear as if combed; rarely erect, pin-like and 1 cm high (fig. 1). In some specimens richly branched in the upper part of the pseudopodetia, thus

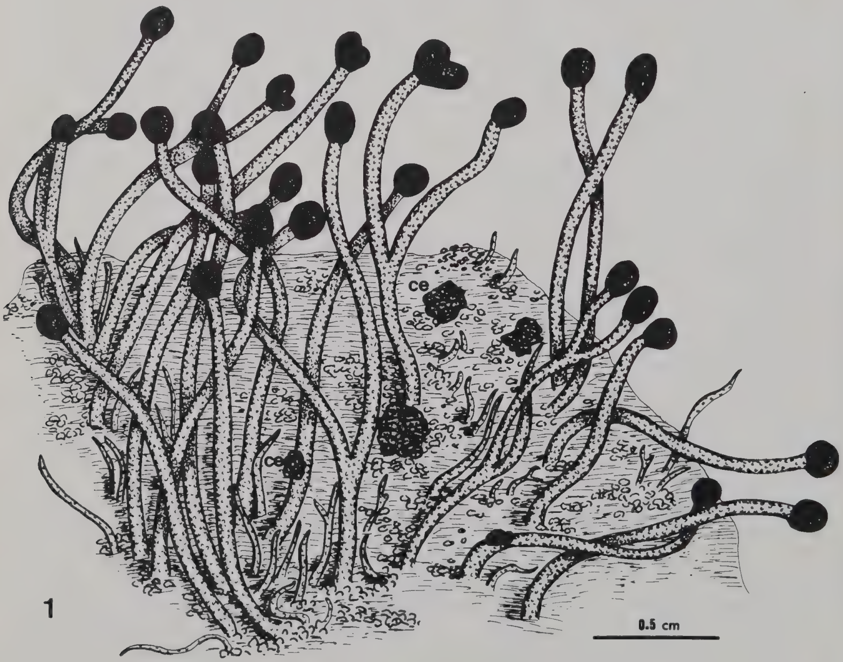


fig. 1 *P. acicularis* (ce - cephalodium)

faintly resembling *P. robustus*. Internally the pseudopodetia are solid when young, becoming hollow with age, composed of long, thin, strongly gelatinized hyphae with narrow lumina (0.5 um). The lower part of older pseudopodetia becomes blackened internally. Algal layer not continuous, in more or less distinct granules, entirely absent from some parts of the surface.

Pycnidia occur in the tips of small sterile pseudopodetia or in the tips of small lateral branches of older pseudopodetia. Conidiophores 30 µm long, unbranched, with terminal sickle-shaped conidia, 6 x 1 µm.

Apothecia abundant, one or several on the apices of the pseudopodetia, black, hemispherical or indistinctly triangular, up to 1.5 mm diameter. There is no columella.

Hymenium up to 240 µm high, two-thirds pigmented, lower part sterile, consisting only of paraphyses. Excipulum absent. Asci eight-spored. Spores rounded when young, becoming spindle-shaped when mature, 21.0-29.5 x 4.5-5.5 µm. Generative tissue formed of closely interwoven hyphae with short, broad cells with large lumina. The generative tissue is pigmented black-brown, the color being most intense below the paraphyses, becoming less so towards the stalk region.

Phycobiont green, *Pleurococcus* type, cells c. 9 µm diameter.

Cephalodia on the thallus horizontalis are brown and hemispherical and contain *Nostoc*. Kurokawa and Shibuichi (1970) found cephalodia containing *Stigonema*. Small cephalodia also occur on the pseudopodetia (fig. 1).

Growing on silicate stone, seldom on decaying wood (one specimen).

Remarks

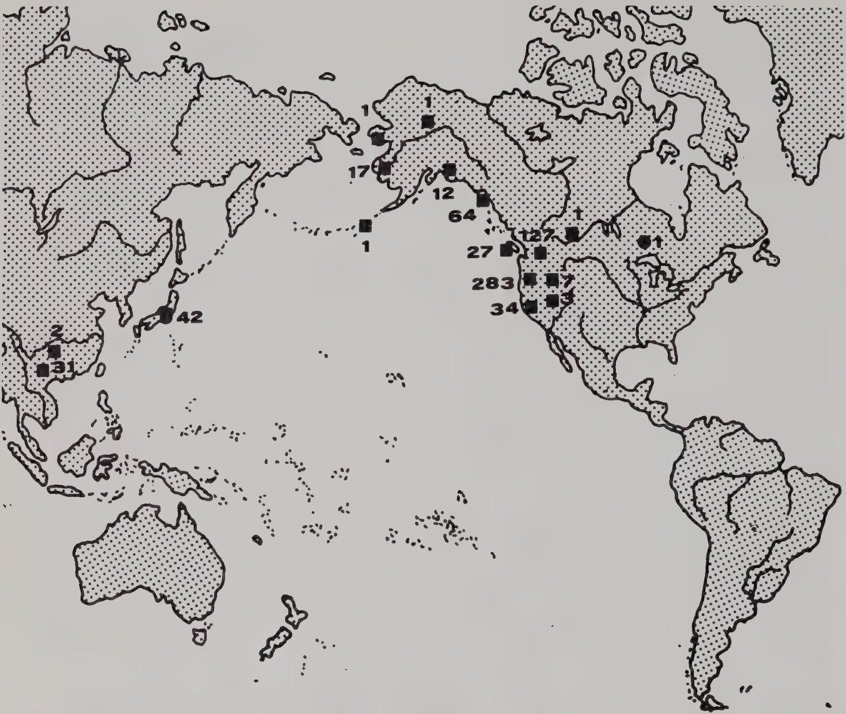
The correct citation for the species is *P. acicularis* (Ach.) Th.Fr. (1857, p.41) and not *P. acicularis* (Ach.) Nyl. (1857, p.96) as explained earlier (Jahns, 1970b).

P. acicularis can be separated from the smaller species by its tall pseudopodetia. It may be confused with *P. robustus*, especially in material from Alaska where both species occur together. But usually the type of branching is different (umbellate in *P. robustus*, dichotomous in *P. acicularis*) and the lack of a columella in longitudinal sections of the fruitbodies of *P. acicularis* always makes distinction easy.

Th. Fries (1889, p.765) described *P. acicularis* var. *conjugens* Th.Fr. from Vancouver Island, which is said to resemble *P. robustus*. I have seen the original material and can see no difference from numerous other specimens which are not worthy of varietal status.

Distribution (map 1)

P. acicularis is probably the most abundant species of the genus. Most specimens were found on the west coast of North America, with a focal point in British Columbia and Washington. The species is widely spread in Japan too. In general this species seems to prefer an oceanic climate without extremely low temperatures, at least in comparison with other species of the genus. This assumption is supported by the fact that this species is found more southerly (34 findings in California) than all other



map 1 *P. acicularis* - distribution (places listed ● and not listed ■ in the description of the species)

species and only two specimens were found in northern Alaska where, for example, *P. robustus* and *P. vegae* occur more often. East of the Rocky Mountains *P. acicularis* is rare too. It is very difficult to give any estimate on the occurrence of the species in China. Although there are only three places known to me where the species has been found, at least one gathering was large enough for the distribution of numerous specimens as an exsiccate (Krypt. Vind. Exs. 2842). Therefore, it may be suggested that *P. acicularis* is not rare in China, but simply has not been collected.

Places outside the main distribution area (map 1, marked by a circle):
Canada, Ontario, Belleville (CAN).

Pilophorus awasthianum Räs., Arch. Soc. Zool. Bot. Fenn. Vanamo 5:28-29 (1950). Type collection: India orientalis, Himalaya orientalis, Darjeeling, 3500 m (H, holotype).

Thallus horizontalis persistent or evanescent, consisting of loosely scattered granules, c. 0.1 mm diameter, grey when dry. Pseudopodetia simple or branched, small and very thin, 0.5-1.5 cm high and 0.2-1.0 mm broad. Pseudopodetia partly covered by an algal layer consisting of small granules, but for the most part the stalks

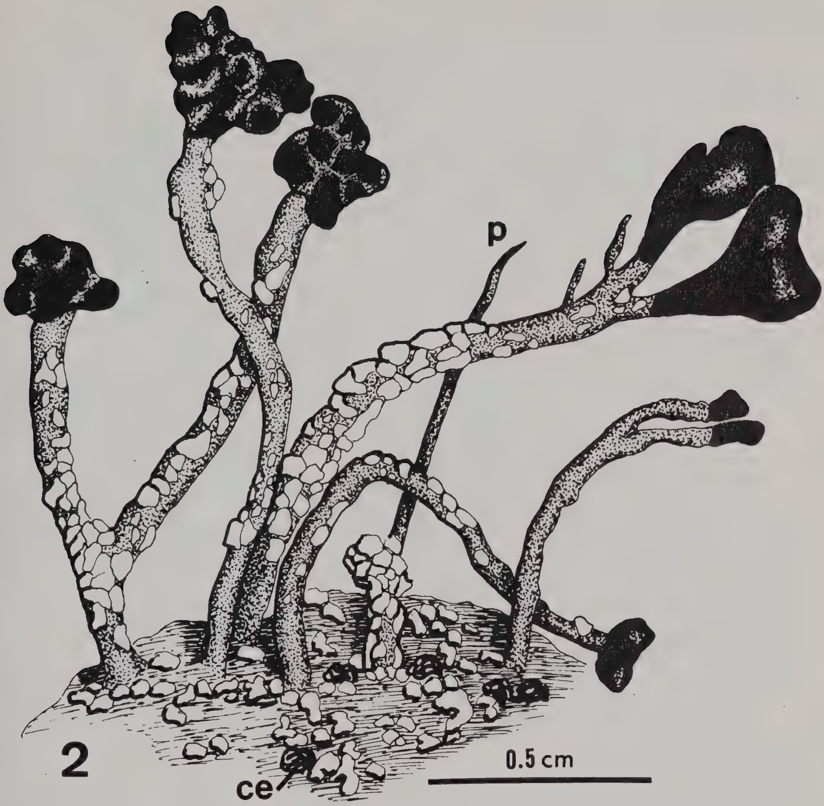


fig. 2 *P. awasthianum* (ce - cephalodium, p - pycnidium)

are bare. The ecorticated parts are blackened, the algal layer grey. Internal part of pseudopodetia solid, formed by strongly gelatinized hyphae.

Pycnidia apical on short pseudopodetia.

Apothecia apical on mature pseudopodetia, sometimes simple and globose but mostly aggregated, consisting of several subglobose bodies (fig. 2). Apothecia 1.5-2.0 mm in diameter. In mature specimens apothecium and pseudopodetium are separated by a pigment-boundary, while boundary-texture and columella are absent. Hymenium c. 100 µm high, excipulum absent. Asci eight-spored, spores spindle-shaped, c. 20 x 7 µm.

Phycobiont green, *Pleurococcus* type, cells c. 10 µm in diameter.

Cephalodia contain *Nostoc*, black, globose, sessile on the thallus horizontalis, c. 0.1 mm diameter.

Growing on silicate rock and earth.

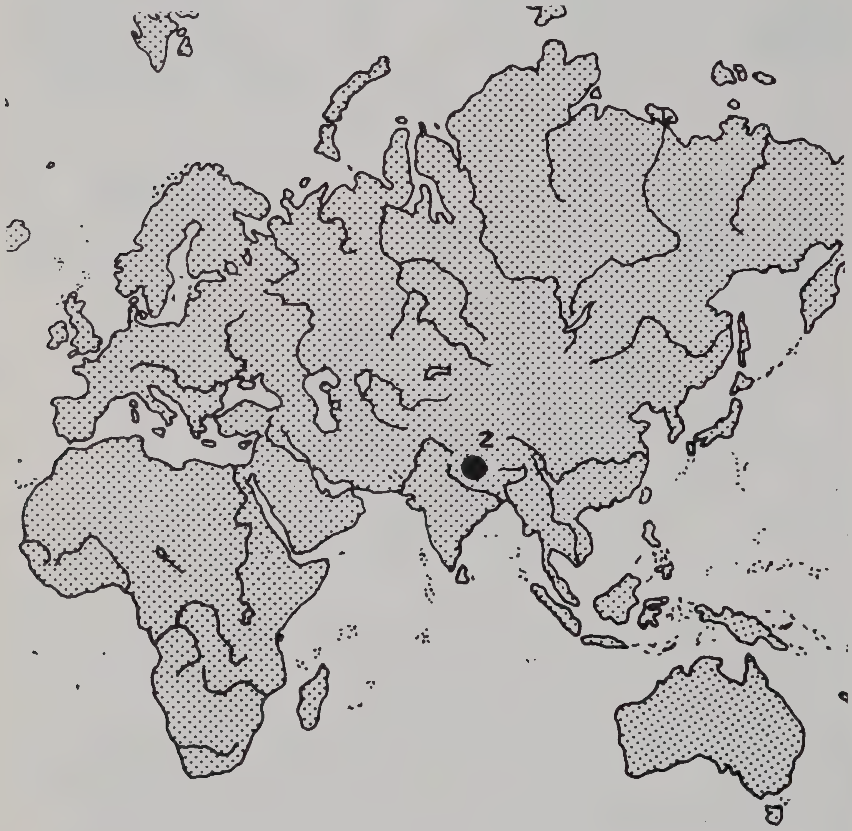
Remarks

P. awasthianum differs from all other species by the small, branched and very thin pseudopodetia and by the strongly aggregated apothecia. As there are only two known specimens so far, the range of variation of the different characteristics is unknown.

Distribution (map 2)

The species is only known from the Himalayas. I have seen the following specimens:

India, Darjeeling district, E. Himalayas, Awasthi, 1948 (H, holotype); India Sandakhpu, Awasthi, 1950 (UPS).



map 2 *P. awasthianum* - distribution

Pilophorus cereolus (Ach.) TH.Fr., Lich. Scand. 1, 1: 55 (1871).
Lichen cereolus Ach., Lich. Suec. Prodr.: 89 (1798); Meth. Lich.: 316 (1803). Type collection: Sweden, Facklelaf, E. Acharius (H, holotype).

Thallus horizontalis persistent, consisting of loosely aggregated, sorediate granules, c. 0.1 mm diameter, grey-green when dry. Pseudopodetia pin-like, usually up to 5 mm (occasionally up to 1 cm) high, 1.5 mm broad, sorediate. Sterile stalks or those

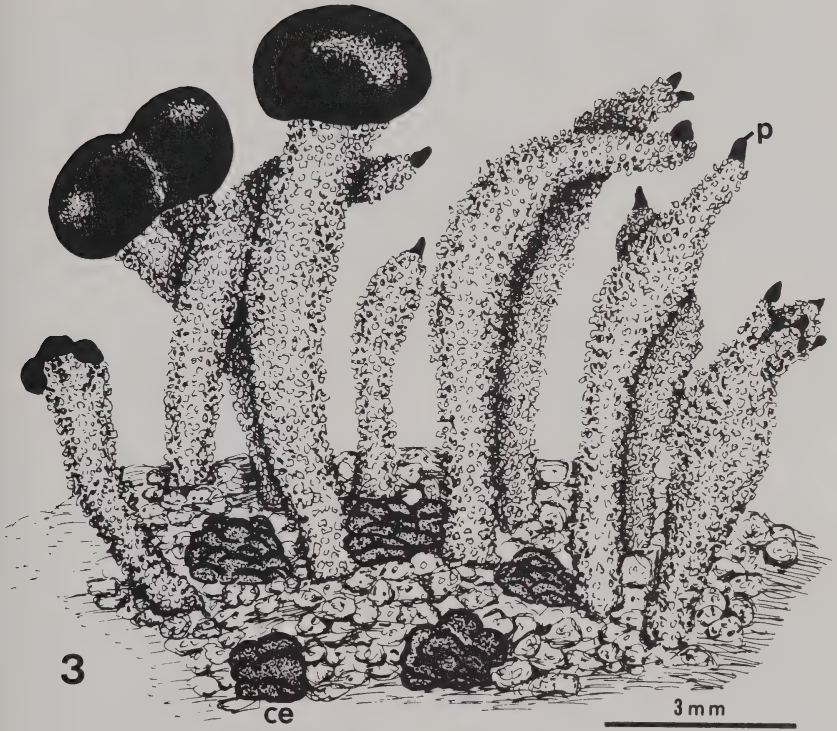


fig. 3 *P. cereolus* (ce - cephalodium, p - pycnidium)

bearing only pycnidia are usually broadest in the middle and irregularly curved (fig. 3). In some specimens, especially in the few American samples, the upper part of the pseudopodetium is slightly branched, each branch bearing a pycnidium or a primordium of a fruitbody. Internally the stalks are compact, composed of strongly gelatinized hyphae with narrow lumina. The phycobiont layer is granular sorediate.

Pycnidia bottle-shaped, abundant, several often produced at the apex of a pseudopodetium. Conidiophores c. 25 µm long, unbranched, with terminal conidia. Conidia sickle-shaped, 5 x 1 µm.

Apothecia scarce, solitary or seldom two on one stalk, spherical, black and terminal, up to 1.5 mm diameter. In longitudinal sections the apothecium is spherical and without a columella. The boundary between the generative and vegetative tissue remains horizontal with the lower margin of the apothecium. In old apothecia a strongly colored pigment-boundary is situated at this juncture. An indistinct boundary-texture may sometimes be developed. Hymenium c. 80 µm high, almost unpigmented. Excipulum absent. Asci eight-spored. Spores rounded when young, becoming spindle-shaped when mature, 14.5-21 x 5.5-6.5 µm. The regions just below the paraphyses and in the pigment-boundary are deep black-brown, towards the center of the apothecium the color grades to pale brown.

Phycobiont green, *Pleurococcus* type, cells c. 9 µm diameter.

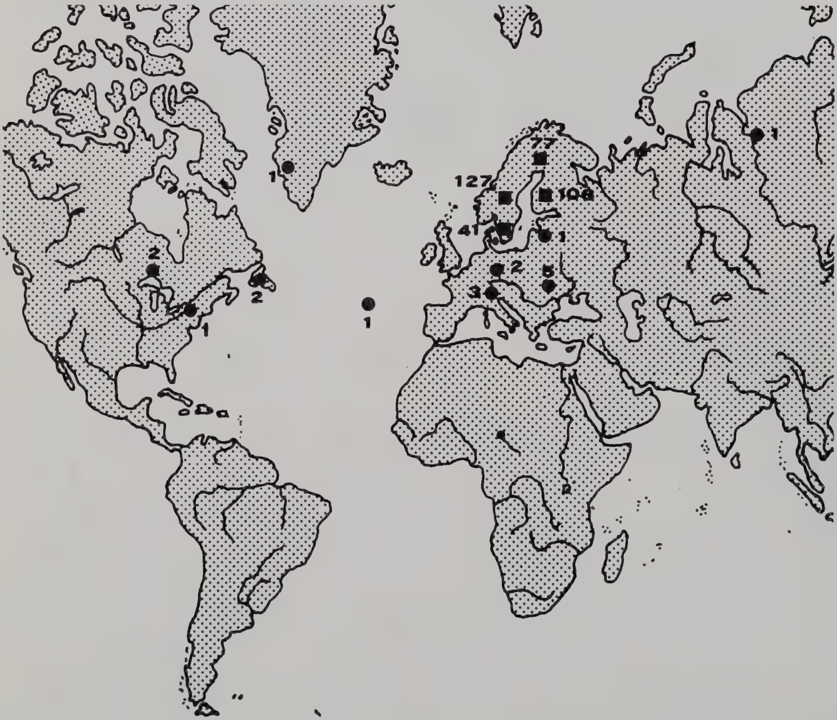
Cephalodia brown, clustered, sessile on the thallus horizontalis, c. 1-2 mm in diameter. Their surface is usually wrinkled. The cephalodia contain *Nostoc* or sometimes *Stigonema*.

Growing on silicate stone.

Remarks

P. cereolus is distinguished from all the other species by the sorediate thallus horizontalis and pseudopodetia. Without this characteristic fruiting specimens of *P. cereolus* could be mistaken for *P. strumaticus, P. fibula, P. curtulum* or *P. nigricaule,* as all these species are of about the same height and pin-like in appearance. The pseudopodetia of *P. vegae* sometimes have a granular cortex, which could be considered as sorediate, but the habit of the species distinctly differs from *P. cereolus* (fig. 3 and 11). Another important characteristic for the distinction of the small, pin-like species is the longitudinal section of the fruitbodies (fig. 12-15).

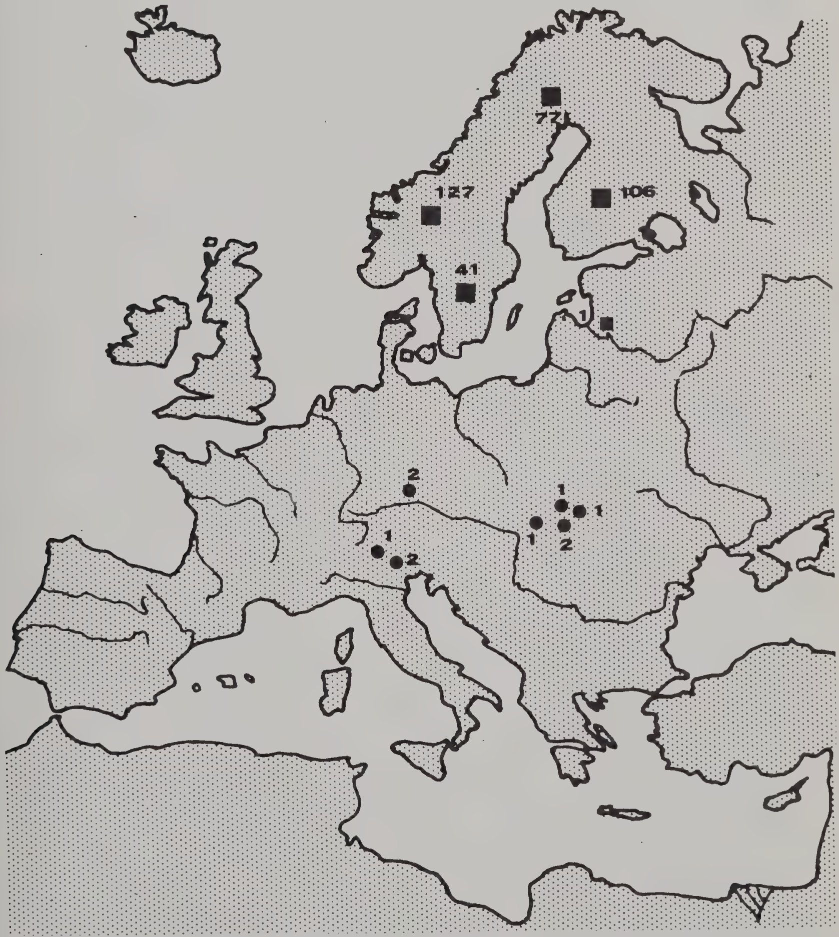
Tuckerman, in his later works (e.g. Tuckerman, 1882, p.235) considered all other species to be varieties of *P. cereolus.* As a result, many subsequent authors have attributed all species of the genus to this species. As pointed out by James (1965, p.139) "*P. cereolus*" as used



map 3 *P. cereolus* - world distribution (places listed ● and not listed ■ in the description of the species)

by British authors refers mostly to *P. strumaticus* and not to the present species. In the same way "*P. cereolus*" as used by many American authors refers to *P. acicularis*.

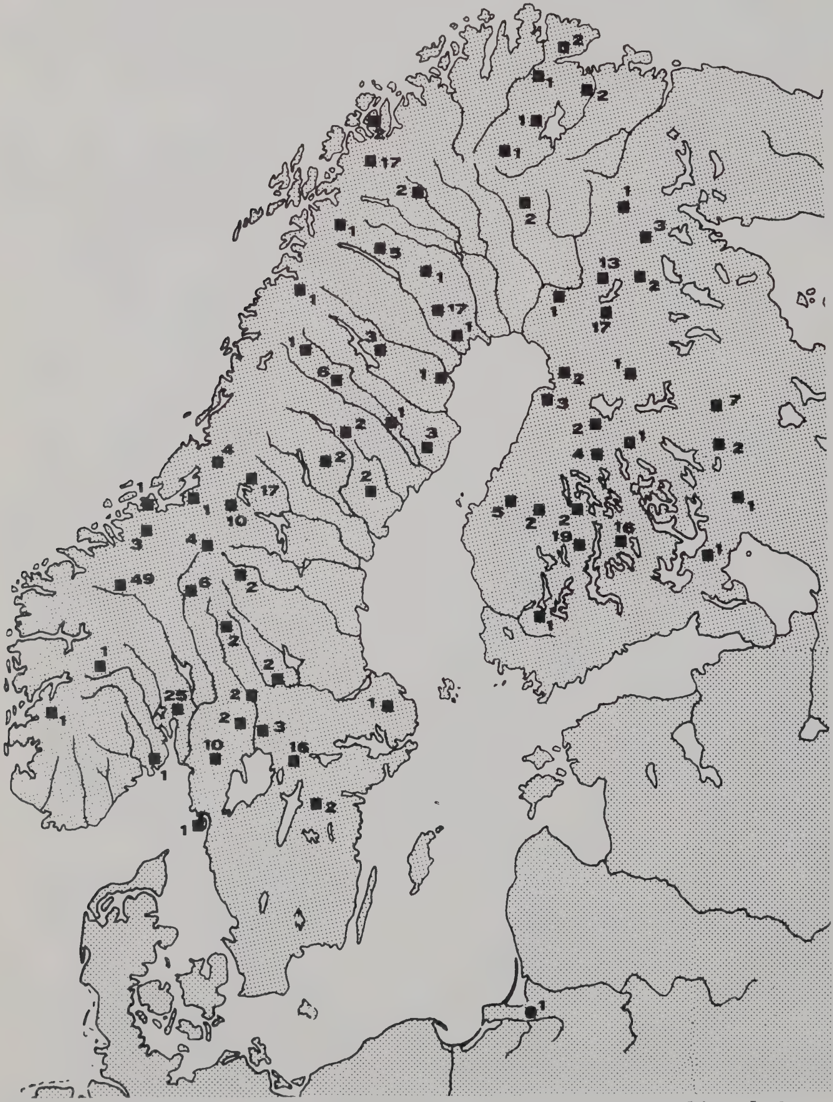
Räsänen (1946, p.2) described *P. cereolus* var. *cephalodiferus* Räs., which he said is to be distinguished by the smaller pseudopodetia and the abundant, markedly tuberculate cephalodia. The syntype material of this variety was distributed in Lich. Fenn. Exs. as no. 960. The samples are in no way different from a multitude of other poorly-developed specimens and should be considered merely as juvenile specimens which are not worthy of varietal status.



map 4 *P. cereolus* - distribution in Europe (places listed ● and not listed ■ in the description of the species)

Distribution (map 3-5)

P. cereolus is the most abundant species of the genus in Europe. Most samples were collected in Scandinavia where its occurrence overlaps with the distribution of *P. robustus* and *P. strumaticus*. However, *P. strumaticus* is restricted to the oceanic climate of the Norwegian and Swedish west coasts, and *P. robustus* occurs in the Norwegian highlands and in the Arctic only, whereas *P. cereolus* is spread over



map 5 *P. cereolus* - distribution in Scandinavia (places listed ● and not listed ■ in the description of the species)

Scandinavia, including Finland. The absence of *P. cereolus* in Great Britain suggests that this species, unlike *P. strumaticus,* dislikes an oceanic climate. This agrees with the observations made by Ammann and Ammann (1969).

Outside Scandinavia *P. cereolus* shows an interesting distribution (maps 3-4). These rare but widely-spread findings are listed further on. While a specimen from northern Poland links up reasonably well with Scandinavia, the occurrence in Siberia appears somewhat isolated. However, the material from Siberia is well developed and was most certainly very abundant as samples of this material can be found in many herbaria. A somewhat bigger group of findings originates from the Carpates and the Tatra (Czechoslovakia), partly distributed as an exsiccate (Lojka, Lich. Hung. 179).

In the Alps this lichen is apparently far less abundant than might be expected from the older literature. Although I have not seen all material mentioned in older publications it seems that most samples belong to *Stereocaulon,* especially *Stereocaulon pileatum,* which is small and corediate and looks somewhat similar to *P. cereolus.* Numerous specimens originate from the Oberpfalz in southern Germany. These and material from South Tyrol have been distributed as exsiccatae (Arnold, Lichenes exs. 823, 1088), but apparently it has been found only in a few places. The lichen seems to be absent from the rest of Germany and the more western countries.

The literature does not give any clue to the distribution of *P. cereolus* in North America as *P. cereolus, P. acicularis* and *P. fibula* were completely confused until recently. In particular, *P. acicularis* was designated as *P. cereolus* in many cases. Krog (1968) remarks, that she has not seen any authentic specimen of *P. cereolus* from western North America. She mentions one single specimen which she has not seen herself, but which from the description could have been *P. cereolus.* I had the chance to see this sample and it proved to be *P. acicularis* too. We may, therefore, conclude that *P. cereolus* does not occur in the western parts of North America. In the eastern part of the continent there are three places where true *P. cereolus* has been found. One of which (Grand Marais) was described by Fink (1910) who, however, thought it to be identical with the *P. cereolus* described by Tuckerman and which in fact was *P. acicularis.* The American material is not fully developed and slightly different from the European material. Nevertheless, it seems to be the same species and its distribution in North America is linked to the main distribution area in Europe by findings from Newfoundland, Greenland and the Azores.

Places outside the main distribution area (map 3-5, marked by a circle):

Canada, Newfoundland, upper Humber River (H); Canada, Newfoundland, New Harbour, Trinity Bay (M); Canada, Minnesota, Grand Marais, along the northern shore of Lake Superior (4 specimens MICH, 1 specimen US); Canada, Minnesota, Cook County, 8 miles SW of Grand Marais on US Route 61, Cascade River State Park, along Cascade River (CAN); USA, New York State, Adirondack Region, Chapel Pond, near St. Huberts (MICH); Greenland, Diskofjord, Kuanersuit suvdlat (C); Azores, Santa Maria, Pico Alto (James and Henssen unpublished) (MB); Germany, Oberpfalz, above Spielberg near Nabeck west of Schwandorf (11 specimens BM, C, H, KIEL, M, O, PR); Germany, Oberpfalz, Schutzengelsteinbruch, Eldensteiner Forst (M); Austria, Tyrol, Silz, Intal (2 specimens M); Italy, South Tyrol, Margola near Predazzo (25 specimens B, BM, BP, FH, H, LD, M, O, S, W); Italy, South Tyrol, between Bellamonte and Paneveggio (4 specimens BM, BP, M, W); CSSR, Presov, Ö. Szatala (BP; CSSR, alpes Dzurowa prope pagum Teplicska, com. Lipto (W); CSSR, Slovakia, Nizke Tatry, in valle rivi Svidovy (PR); CSSR, Slovakia, Nizke Tatry, in valle rivi Svarinsky (PR); CSSR, in sylva Stefkofka prope Bresztova, com Arva (16 specimens B, BG, BP, FH, G, H, LD, M, O, PR, S, US, W); Poland, prope Labiau (H); USSR, Dudinka, Yenisey, lat. bor. 69°35' (7 specimens FH, H, O, S, UPS).

Pilophorus clavatus Th.Fr., Bot. Notiser, 1888: 214 (1888). Type collection: Canada, British Columbia, Vancouver Island, Mt. Mark, 1887, Macoun (UPS, holotype).
P. acicularis f. *hallii* Tuck., Proc. Am. Acad. Arts Sci. 12: 177 (1877). Type collection: USA, Oregon, Hall (UPS, isotype).
P. cereolus var. *hallii* (Tuck.) Tuck., Syn. N. American Lich.: 235 (1882).
P. hallii (Tuck.) Vain., Bot. Mag., Tokyo 35: 59 (1921).
P. japonicum Zahlbr. (nomen nudum), Catal. Lich. 4: 432 (1926); Bot. Mag., Tokyo 41: 337 (1927).

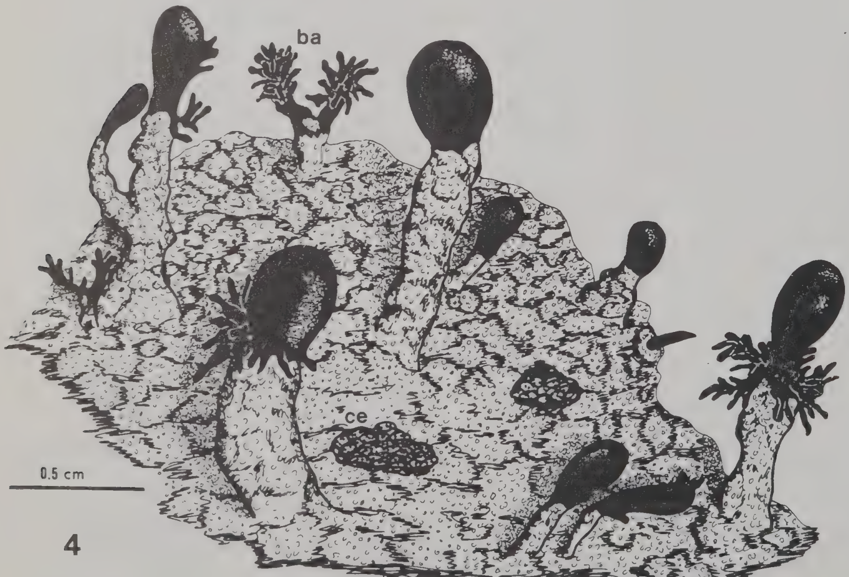


fig. 4 *P. clavatus*, with young fruitbodies (ba - bush-like primordia of apothecia, ce - cephalodium)

Thallus horizontalis thin, granular persistent. Granules often aggregated, forming scales. Granules minute, 0.1 mm diameter, grey-green when dry. Pseudopodetia up to 2 cm high, c. 0.3 mm thick (fig. 5). Internally the central area of the stalk is massive and consists of thin, strongly gelatinized hyphae with thin lumina (0.5 µm). Algal layer not continuous, formed by more or less indiscrete granules, the stalk usually being naked just below the apothecium. Central lower part of the stalks sometimes blackened.

Pycnidia bottle-shaped, apical on short pseudopodetia, about 1 mm high, often bearing thalline scales which form a collar halfway up the stalk. Conidiophores unbranched, 25 µm long, with terminal conidia, 5.0 x 0.5 µm.

Apothecia black, occurring singly at the apex of each pseudopodetium, often spreading some distance down the stalk. The apothecia are triangular in longitudinal section (fig. 16), about 2 (-5) mm high, 1 mm broad at the upper end, tapering to 0.4 mm at the base, often they are more or less bifurcated at the apices (fig. 5). Apothecium sometimes formed by fusion of several primordia growing on bush-like branched pseudopodetia (fig. 4). No columella, boundary-texture, or pigment-boundary is formed between the vegetative and generative tissue. Hymenium c. 200 µm high. Asci eight-spored. Spores rounded when young, becoming spindle-shaped when old, 23.5-26.5 x 5.0-6.0 µm. Hymenium greenish, and the generative tissue uniformly pigmented, black-brown.

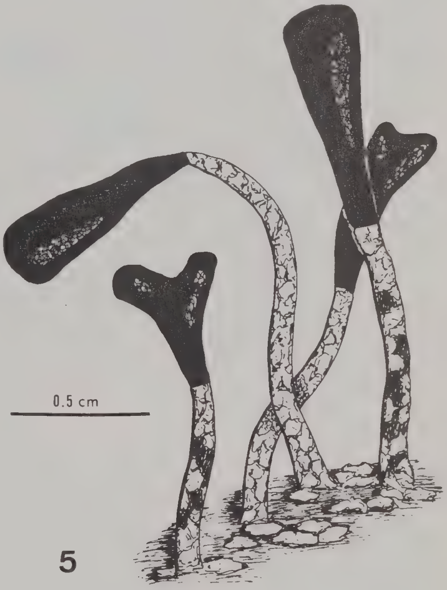


fig. 5 *P. clavatus*

Phycobiont green, *Pleurococcus* type, cells c. 8 µm diameter.

Cephalodia brown-black, irregular, lumpy, about 0.5 mm diameter with a velvety surface. Growing on the thallus horizontalis. They contain *Stigonema* and sometimes *Nostoc*.

Plants growing on silicate rock.

Remarks

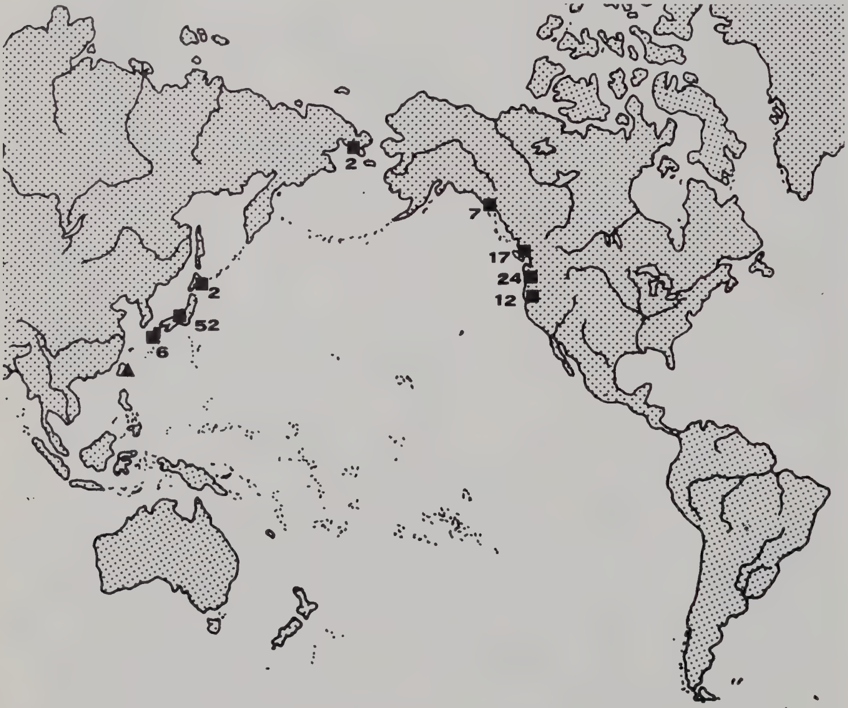
In most specimens the triangular outline of the apothecia is sufficient to distinguish *P. clavatus* from all other species. *P. clavatus* could only possibly be confused with small specimens of *P. acicularis* bearing slightly triangular apothecia. In this case the two species may be separated by their persistent or evanescent thallus horizontalis respectively.

It was explained earlier (Jahns, 1970b) that *P. hallii* is a synonym for *P. clavatus* and that the name *P. clavatus*

Th.Fr. (1888) has priority at the species level over *P. hallii* (Tuck.) Vain. (1921). *P. japonicum* Zahlbr. is a nomen nudum. Zahlbruckner knew it to be a synonym of *P. hallii* but nevertheless preferred his new name.

Distribution (map 6)

The distribution of *P. clavatus* is essentially identical with the occurrence of *P. acicularis*. Both species are found on the coasts of the northern Pacific Ocean, *P. clavatus* apparently being relatively more abundant than *P. acicularis* in Japan. Surprisingly *P. clavatus* has not yet been found in Northern Alaska but was present on the Asiatic side of the Bering Strait. Kurokawa and Shibuichi (1970) have examined material from Formosa and their observation is included in map 6 (triangle), they also mention the species in Korea but don't seem to have examined the material themselves.



map 6 *P. clavatus* - distribution (■ places not listed in the description of the species, ▲ specimens not examined)

Pilophorus curtulum Kurok. and Shib., Journ. Jap Bot. 45, 3: 78 (1970). Type collection: Mt. Ontake, Prov. Hida, Japan (TNS, holotype; FH, O, isotypes).

Thallus horizontalis persistent, consisting of minute granules, 0.1 mm diameter, usually aggregated forming small squamules, 1.5 mm

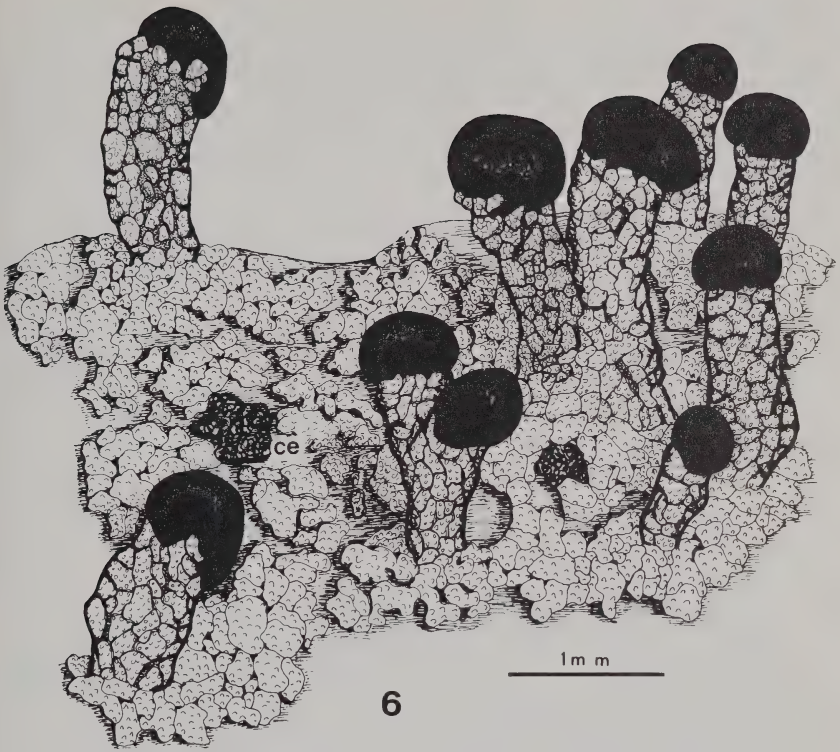


fig. 6 *P. curtulum* (ce - cephalodium)

diameter (fig. 6). Sometimes granules scattered and hardly aggegated. Thallus grey-green when dry. Pseudopodetia pin-like, 1-3 mm high, 0.5-1.0 mm broad. Mostly covered by a continuous algal layer consisting of small granules. Only sometimes ecorticate. Internally the stalks are compact, composed of strongly gelatinized hyphae. Central part of older pseudopodetia colored by deposition of dark pigment.

Pycnidia sessile on the thallus horizontalis.

Apothecia apical on the pseudopodetia, nearly always single, but sometimes two apothecia developed from two primordia have partly merged. Sometimes apothecia sessile on the thallus horizontalis. Apothecia about 1 mm in diameter. In longitudinal sections the apothecium is spherical and without columella. Pseudopodetium and apothecium are separated by a boundary-texture which is formed in the young primordium. In older specimens the boundary-texture is masked by a pigment-boundary. Hymenium c. 150 µm high, almost unpigmented. Excipulum absent, asci eight-spored. Spores rounded when young, becoming spindle-shaped when mature, c. 7 x 22 µm.

Phycobiont green, *Pleurococcus* type.

Cephalodia contain *Stigonema*, they form dark-brown flattened discs between the squamules of the thallus horizontalis.

Growing on silicate rock.

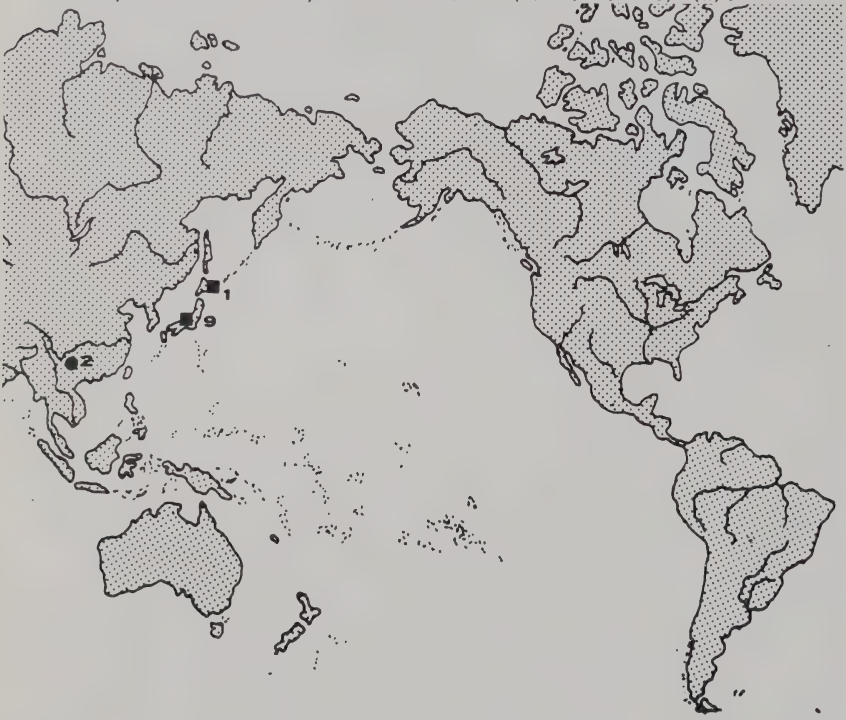
Remarks

This species resembles *P. fibula*. The thallus horizontalis of *P. curtulum* seems to be a bit thinner and less areolated, and the pseudopodetium is somewhat higher and more granulated than in *P. fibula;* but probably the only good reason for keeping the two species separated is their disjunct distribution. *P. curtulum* is only known from Japan and China, while *P. fibula* is endemic to north-east America.

Distribution (map 7)

This lichen has been found in Japan several times. I have seen samples from 10 places. From China I have seen two samples:

China, Yünnan, bor.occid. (O); China, Yünnan, bor.occid.: In montis Waha prope pagum Yungning regione frigide temperata infra casulam Maoniubi, alt. 3800-4030, Handel-Mazetti (Diar.Nr.1286) (W).



map 7 *P. curtulum* - distribution (places listed ● and not listed ■ in the description of the species)

Pilophorus fibula (Tuck.) Th.Fr., De *Stereocaulis* et *Pilophoris* Comm.: 42 (1857).

Stereocaulon fibula Tuck., Proc. Am. Acad. Arts Sci. 1: 238 (1847). Type collection: USA, New Hampshire, White Mts., 1844, Tuckerman (FH-Tuckerman, holotype).

Thallus horizontalis squamulose, squamules large, up to 2 mm diameter, composed of small granules, persistent, grey-green. Pseudopodetia seldom exceeding 1 mm hight, sometimes totally absent so that the apothecia are sessile (fig. 7). Stalk massive, composed of gelatinized thin hyphae with small lumina (0.5 µm). Algal layer more or less areolate, not continuous.

Pycnidia single, in small diminutive pseudopodetia. Conidiophores c. 30 µm long, unbranched, with terminal sickle-shaped conidia, 6 x 1 µm.

Apothecia black, hemispherical, 1 mm in diameter. A pigment-boundary and boundary-texture lies between the generative and vegetative tissues. There is no columella. Hymenium up to 120 µm high, lower-third pigmented. Lower edge of apothecium sterile, consisting only of paraphyses. Excipulum absent. Asci eight-spored. Spores rounded when young, becoming spindle-shaped when old, 17.0-23.0 x 5.5-6.5 µm. A dark-brown pigmented layer occurs under the paraphyses, which becomes paler towards the center of the apothecium.

Phycobiont green, *Pleurococcus* type, cells c. 6 µm diameter.

Cephalodia contain *Stigonema,* they form brown, flattened granular discs, c. 1 mm diameter between the scales of the thallus horizontalis (fig. 7).

Growing on silicate stone.

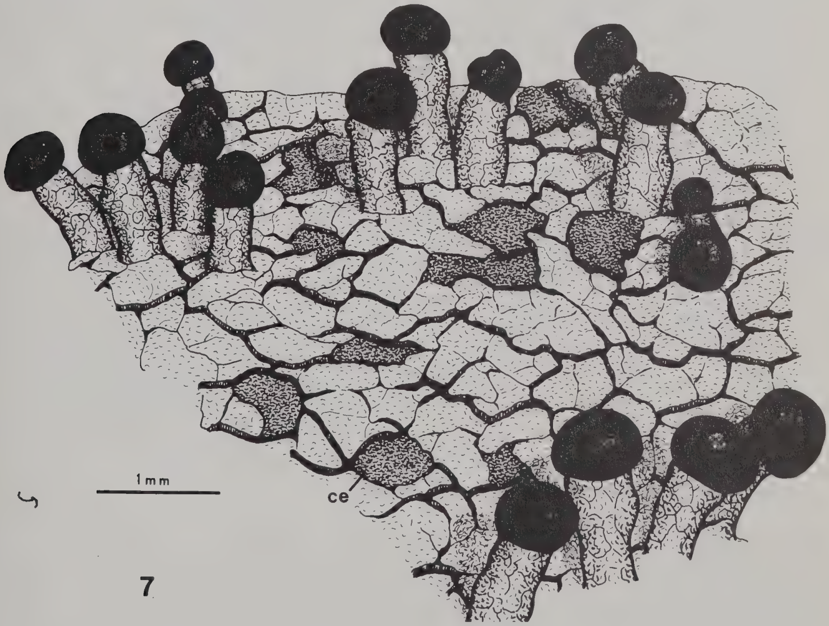


fig. 7 *P. fibula* (ce - cephalodium)

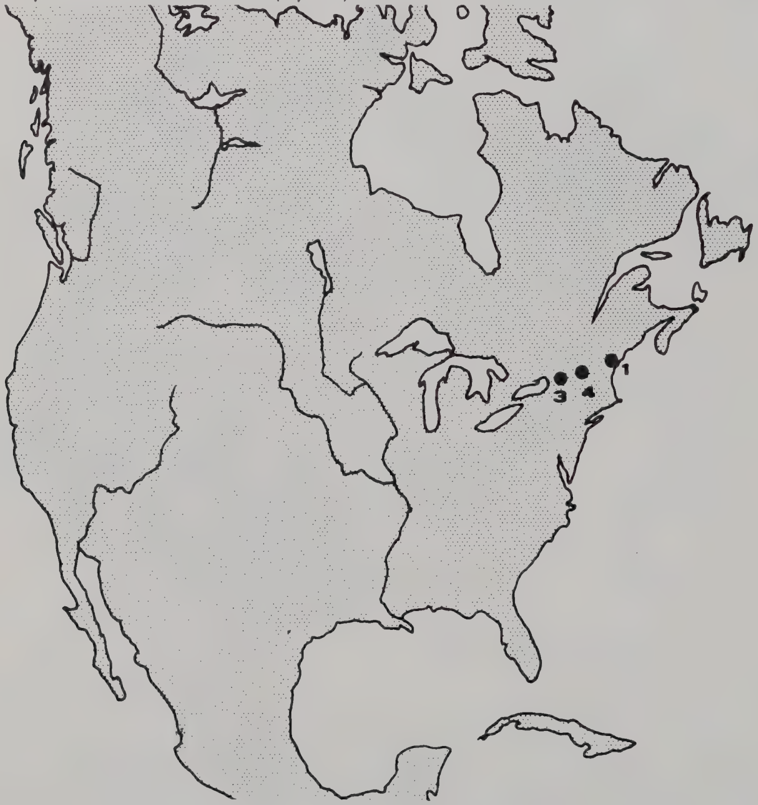
Remarks

Since the first description of *Stereocaulon fibula* by Tuckerman in 1847 this specific epithet has tended to be applied to widely differing small or depauperate specimens of the genus. But *P. strumaticus* and *P. cereolus* differ distinctly from *P. fibula* by the occurrence of a columella in the apothecium or of soredia respectively. Most difficult to distinguish from *P. fibula* is *P. curtulum*, as the differences between the two species are only gradual. The thallus horizontalis of *P. curtulum* is usually but not always less squamulose and less persistent. Moreover, only very old apothecia of *P. curtulum* are separated from the stalk by a pigment-boundary in addition to the boundary-texture which is always present.

Distribution (map 8)

P. fibula occurs only in north-east America and appears to be restricted mainly to the area of the White Mountains. Only two samples originate from the coast. I have seen material from the following places:

USA, New Hampshire, Mont. Alb. (BM, FH, M, MICH, W); USA, New Hampshire, Roche entrance to Ilume, Franconia (F, US); USA, New Hampshire, montibus Nord Anglio (PC); USA, New Hampshire, Warren (US); USA, New York, rock on trail up Mt. MacDetyse near Lake Placid (MICH); USA, New York, Adirondacks, Mt. Marcy (S); USA, New York, Adirondacks, Indian Falls, near Mt. Marcy, near Lake Placid (FH); USA, Maine, Mt. Desert Island (M, US).



map 8 *P. fibula* - distribution (● places listed in the description)

Pilophorus nigricaule Satô, Journ. Jap. Bot. 16: 173 (1940) fig.7.
Type collection: Japan, Honsyû, Mt. Tyôkai (Tokyo, holotype).
Pilophoron cereolus (non Th.Fr.) Satô, Journ. Jap. Bot. 9: 214 (1933).

Thallus horizontalis persistent, white or light grey, granular. Granules c. 2 mm broad and c. 1 mm high, subglobose, aggregated or scattered on the substrate. Most granules slightly peltate. Pseudopodetia pin-like, 1-6 mm high, 1 mm diameter. Internally the stalks are compact, composed of strongly gelatinized hyphae, colored black by the deposition of dark pigment-granules. The pseudopodetia are covered by subglobose granules, showing the same color, morphology and structure as the granules of the thallus horizontalis (fig. 17). In some specimens a few stalks are branched.

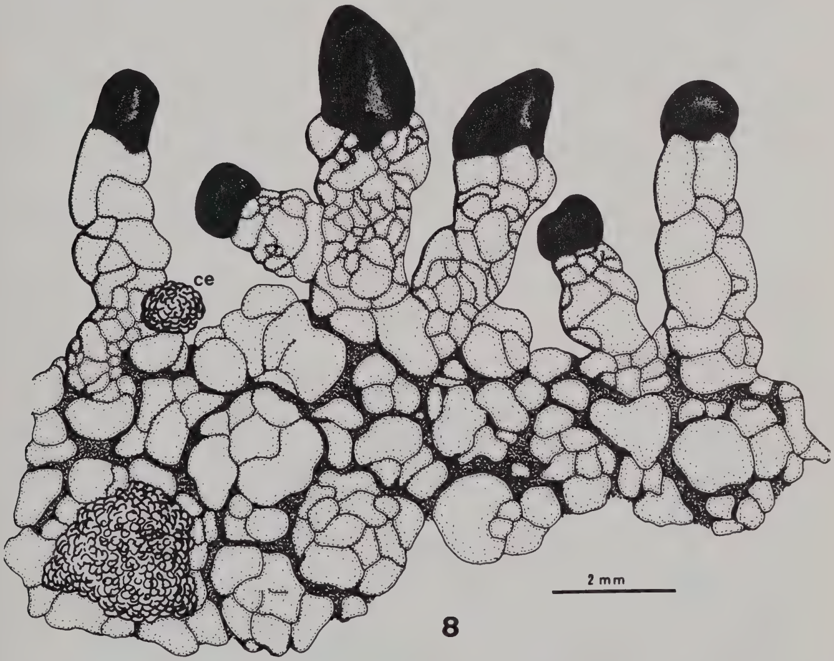


fig. 8 *P. nigricaule* (ce - cephalodium)

Pycnidia apical on short pseudopodetia or sessile on the thallus horizontalis. Conidiophores long, slightly branched with terminal sickle-shaped conidia, c. 10 x 1 µm.

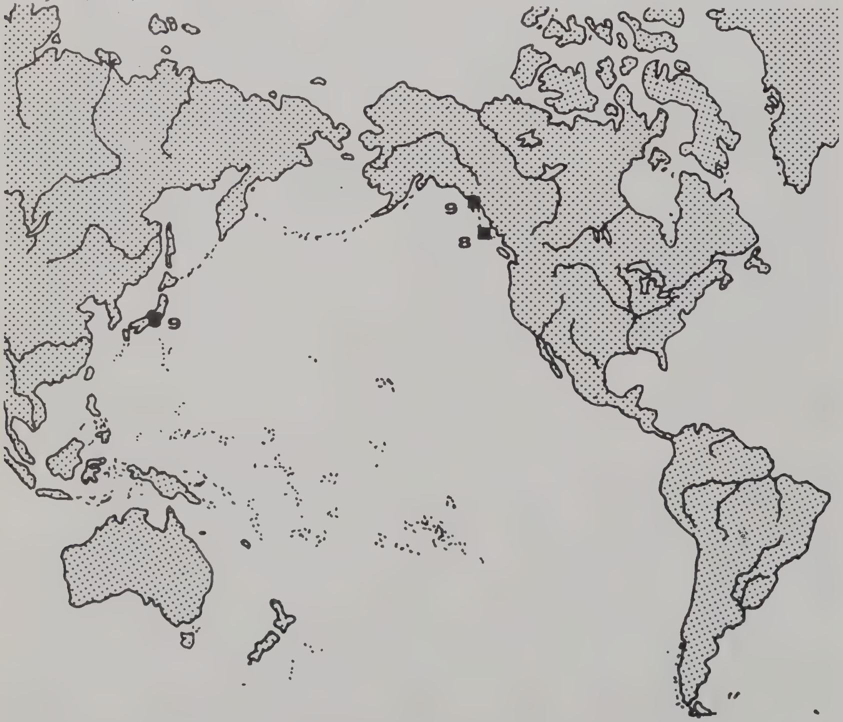
Apothecia terminal on mature pseudopodetia or sometimes sessile on the thallus horizontalis, 1.0-2.5 mm diameter. Apothecial margin downturned as far as the point of attachment to the stalk. Apothecia subglobose or slightly conical (fig. 8). No columella is present. Apothecium and pseudopodetium separated by a broad boundary-texture. No pigment-boundary is present. Hymenium c. 180 µm high, subhymenium 120 µm. Excipulum absent. Asci eight-spored. Spores rounded when young, becoming spindle-shaped when mature, c. 18 x 7 µm.

Phycobiont green, *Pleurococcus* type, cells c. 10 µm diameter.

Cephalodia on the thallus horizontalis, thick, brown to black, with wrinkled surface, c. 0.5 mm diameter, containing *Stigonema*. Growing on silicate rock.

Remarks

P. nigricaule is distinguished from other species by the white color and the thick, subglobose to peltate structure of the thallus horizontalis and of the algal layer of the pseudopodetium. With these characteristics the species is easily distinguished from *P. curtulum*, which is also short stalked and occurs in the same area. On the other hand, the dark color of the central part of the pseudopodetium, from which the species takes its name, is not unique to the species. The stalks of *P. vegae, P. awasthianum, P. curtulum, P. strumaticus* and *P. clavatus* are also more or less blackened within. As Kurokawa and Shibuichi (1970) pointed out, in *P. curtulum* the color of the axis seems to vary with environmental factors. The same applies to the other species with blackened axes, where colorless and hyaline specimens can always be found. The blackened axis appears to have no consistent taxonomic value and therefore this criterion should not be used to divide the genus *Pilophorus* into sections as done by Satô (1940). The taxa *Pilophoron* section *Eupilophoron* Satô (Journ. Jap. Bot. 16: 175, 1940) and *Pilophoron* section *Nigricaulia* Satô (Journ. Jap. Bot. 16: 175, 1940) therefore should be abolished.



map. 9 *P. nigricaule* - distribution

In figure 8 of his paper Satô (1940) gives a scheme of the transverse section of pseudopodetium and apothecium of his two sections. This figure is misleading in several respects. The species of his section *Eupilophoron* are shown to be hollow, which is not true for most species of *Pilophorus*. Only in *P. acicularis* and *P. robustus* do old pseudopodetia sometimes become hollow. The section of *Nigricaulia* shows a black central column of the pseudopodetium, which passes directly into the central part of the apothecium. In reality the apothecium and the pseudopodetium are not only of different ontogenetic origin, but are also distinctly separated by the boundary-texture. Furthermore, the pigment is not restricted to the axis of the pseudopodetium, but the phyllocladia and the thallus horizontalis are also pigmented.

Distribution (map 9)

The distribution of *P. nigricaule* corresponds with the occurrence of *P. acicularis* and *P. clavatus*, but the species is much rarer. Until now *P. nigricaule* has been found in two areas only: Japan and the west coast of America.

Pilophorus robustus Th.Fr., De *Stereocaulis* et *Pilophoris* Comm.: 41 (1857). Type collection: Norway, Hedmark, Österdal, Amot, Austa-elv, 1837, Blytt (UPS, holotype).

Pilophoron polycarpum Tuck., Am. Journ. Arts Sci. 2, 15: 427 (1858). Type collection: Bering Straits (FH).

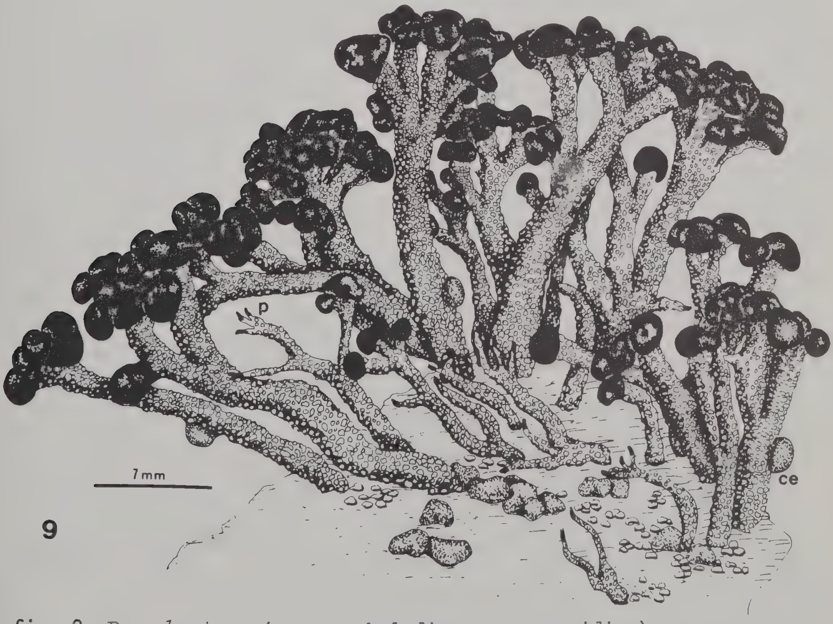


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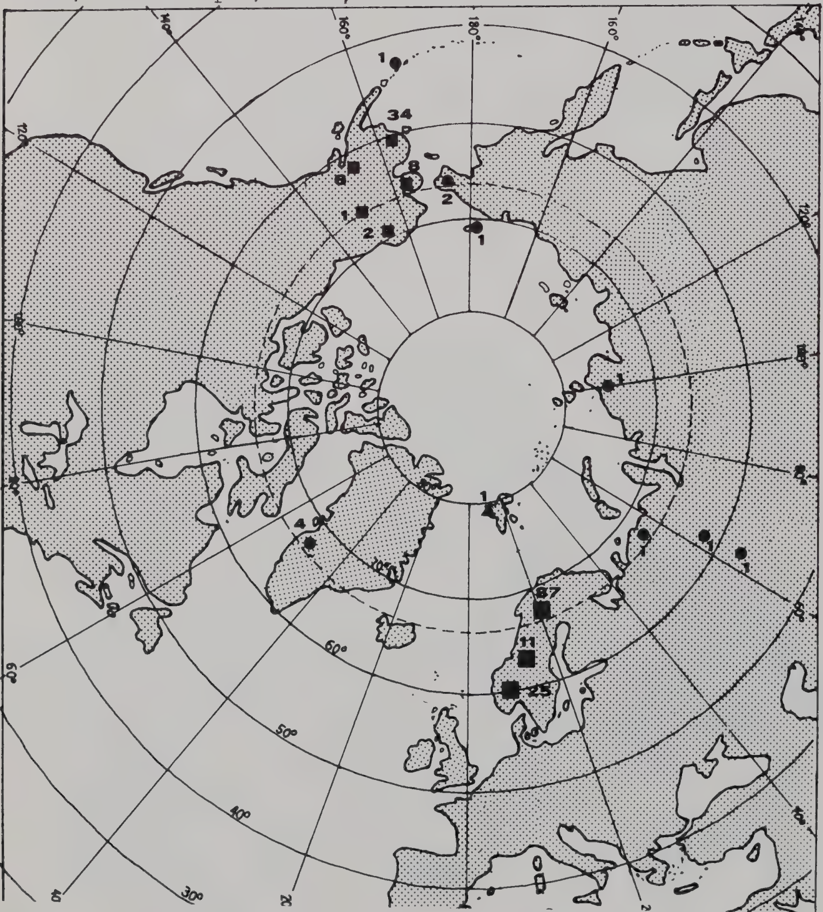
fig. 9 *P. robustus* (ce - cephalodium, p - pycnidium)

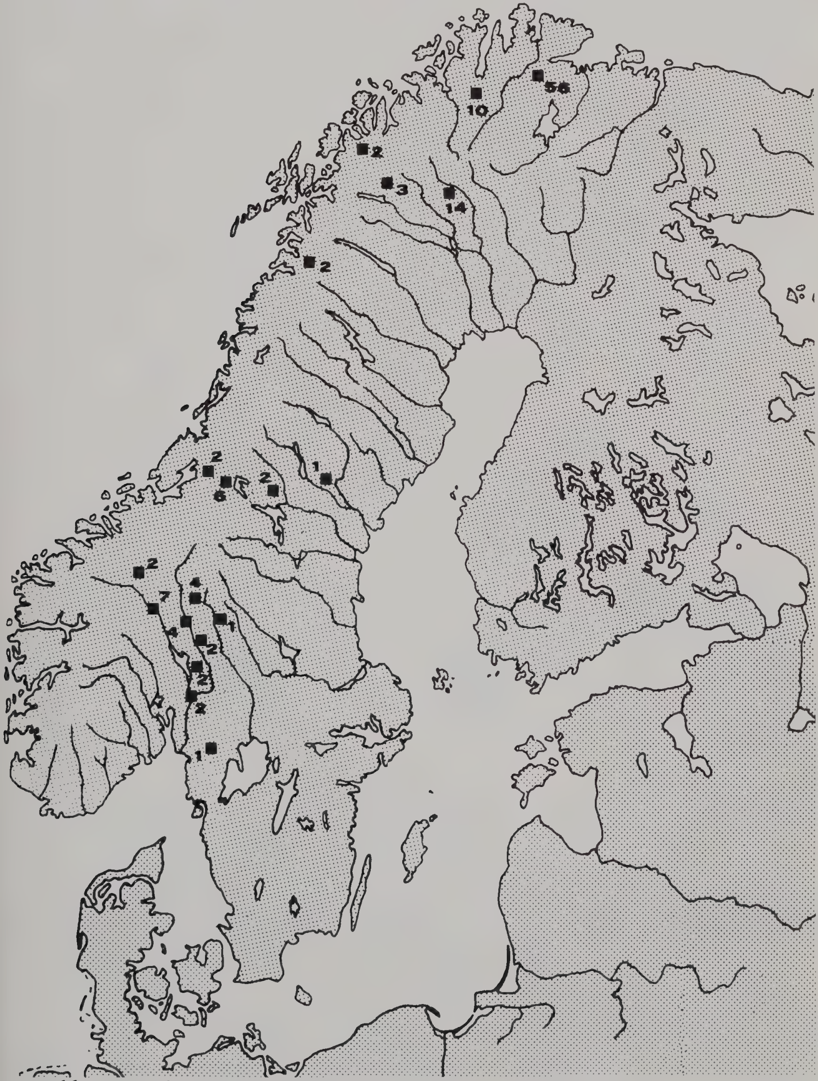
Thallus horizontalis granular or pulverulent, or indistinctly squamulose, evanescent in older specimens, grey-green when dry. Granules about 1 mm diameter. Pseudopodetia stout, massive, seldom becoming hollow when old, irregularly or umbellately branched in the upper part, normally 1.0-2.5 cm high, but sometimes up to 5 cm high and 3 mm broad (fig. 9). Hyphae of stalk strongly gelatinized with very small lumina (c. 0.5 µm), cells at least 10 µm in length, orientated more or less parallel to the longitudinal axis of the pseudopodetium. Algal layer not homogenous, separated in loose granules. Old pseudopodetia becoming more or less decorticate. Cortex-granules c. 0.2 mm diameter.

Pycnidia bottle-shaped, apical on the tips of short lateral branches or at the tip of smaller young pseudopodetia (fig. 9). Conidiophores c. 10 µm long, unbranched with elongate cells. Conidia terminal, sickle-shaped, 5 x 1 µm.



map 10 *P. robustus* - world distribution (places listed ● and not listed ■ in the description. ▲ specimens not examined)

Apothecia numerous, crowded at the apices of the pseudopodetial branches, usually c. 2.5 mm (from 0.5 to 4 mm) broad, 1.5 mm high, globose. Margins of crowded apothecia sometimes grown together secondarily. Margin of the hymenium extending downwards below the point of attachment to the stalk, curving inward and upward before reaching the pseudopodetial surface. Vegetative tissue forming a large columella within the apothecium (fig. 12). In young specimens only a small columella is present. Boundary-texture and pigment-boundary absent. Hymenium c. 200 µm high, lower-half pigmented.



map 11 *P. robustus* - distribution in Scandinavia

Asci eight-spored. Spores simple, rounded when young, spindle-shaped when mature, 18.0-24.0 x 4.0-6.5 µm. In one specimen some apothecia without pseudopodetia sessile on the thallus horizontalis.

Phycobiont green, *Pleurococcus* type, cells c. 9 µm diameter.

Cephalodia large, brown to orange, lumpy, 1.0-1.5 mm diameter, situated on the thallus horizontalis and on lower parts of older pseudopodetia (fig. 9), with *Nostoc*.

Growing on silicate rock and small stones.

Remarks

Pilophorus robustus can be separated from all the other species by the relatively tall, umbellately branched pseudopodetia, the evanescent thallus horizontalis, and the large and well-developed columella in the apothecium. In some specimens the very young and small pseudopodetia resemble *P. cereolus*, but the latter is always sorediate. In some cases certain specimens of *P. robustus* and *P. acicularis* might be confused, especially in material collected in Alaska, where both species occur together. This error is possible if the pseudopodetia of *P. acicularis* are richly branched in their upper part and thereby resemble the umbellately branched thalli of *P. robustus*. But the two species can always be distinguished from the occurrence of a columella in the apothecium of *P. robustus*.

Unusually small or very large specimens are quite frequently encountered in this species. Some specimens from different parts of the world are barely 1 cm high and have pseudopodetia of less than 1 mm in diameter. Others may have pseudopodetia up to 5 cm high and 6 mm broad at the base. Among these large specimens is *P. robustus* f. *magnus* Savicz (1941), but the type-material is in no way unique among the specimens examined. It is very interesting that unstalked apothecia which grew directly from the thallus

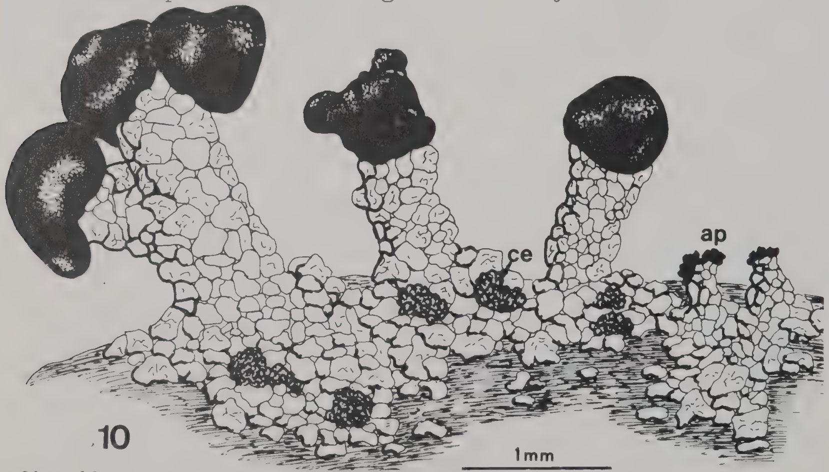


fig. 10 *P. strumaticus* (ap - primordium of apothecium, ce - cephalodium)

horizontalis were found. This is quite common in species with small pseudopodetia such as *P. fibula*, but is rather unusual in the larger species.

Distribution (map 10-11)

P. robustus shows a distinct arctic, circumpolar distribution. In Scandinavia where most samples were found the species is almost exclusively restricted to the high mountains as was already established by Ammann and Ammann (1969); but here too, its clear dominance in northern regions is obvious. A second center of distribution is Alaska and the Tschuktschen Peninsula. These two main areas are connected by specimens collected in Siberia, Spitsbergen and Greenland. I have not seen the material from Spitsbergen myself, but the information was given by Krog. Specimens found outside Scandinavia and Alaska:
Spitsbergen, Svenskeøya, Kong Karlsland, E.Dahl, 1936; Greenland, Laksefjord (C); Greenland, Laksefjord, Proven District (C); Greenland, Diskofjord, Kuanersuit (C); Greenland, Disko, Nordfjord, Kugssinerssuaq (C, 2 specimens); USA, Alaska, Aleutian Islands, Amchitka Island (WIS); USSR, Tschuktschen Peninsula (2 specimens LE, M); USSR, Arakamchechen Is., Tschuktschen Peninsula (BM, FH, PC, US); USSR, Wrangel Island (3 specimens LE); USSR, Taimyr Peninsula (3 specimens LE; GB, 2 specimens S); USSR, Laja River, Bolchesemelskaja (LE); USSR, Tobolsk (LE); USSR, Beresow, near Tobolsk (LE, O).

Pilophorus strumaticus Nyl. ex Cromb., Monogr. Lich. Brit.: 115 (1894). Type collection: Great Britain, S. Aberdeenshire, Braemar, Morrone, 1869, Crombie (BM, lectotype).
P. robustus f. *distans* Hult., Bih. K. svenska Vetensk. Akad. Handl. 26: 17 (1900). Type collection: Sweden, Dalsland, Hattefjäll, prope Vagsäter, 1870, Hulting (GB, lectotype; UPS, lectoparatype (1895)).
P. distans (Hult.) Magn., Bot. Notiser 108: 298 (1955).

Thallus persistent, minutely granular or nearly squamulous; granules 0.1 mm diameter, often becoming confluent to form aggregations c. 1 mm in size, grey when dry. Pseudopodetia pin-like, up to 2 mm high, 0.5 mm diameter (fig. 10). Internal hyphae strongly gelatinized, cell lumina 0.5 µm wide, hyphae of upper part usually grey-brown. Pseudopodetia mostly covered by a layer of algae in continuous granules or squamules.

Pycnidia apical on short pseudopodetia, up to 0.5 mm high, often surrounded by a collar of granules or cortical scales. Conidiophores c. 45 µm long, unbranched with terminal sickle-shaped conidia 6 x 1 µm in size.

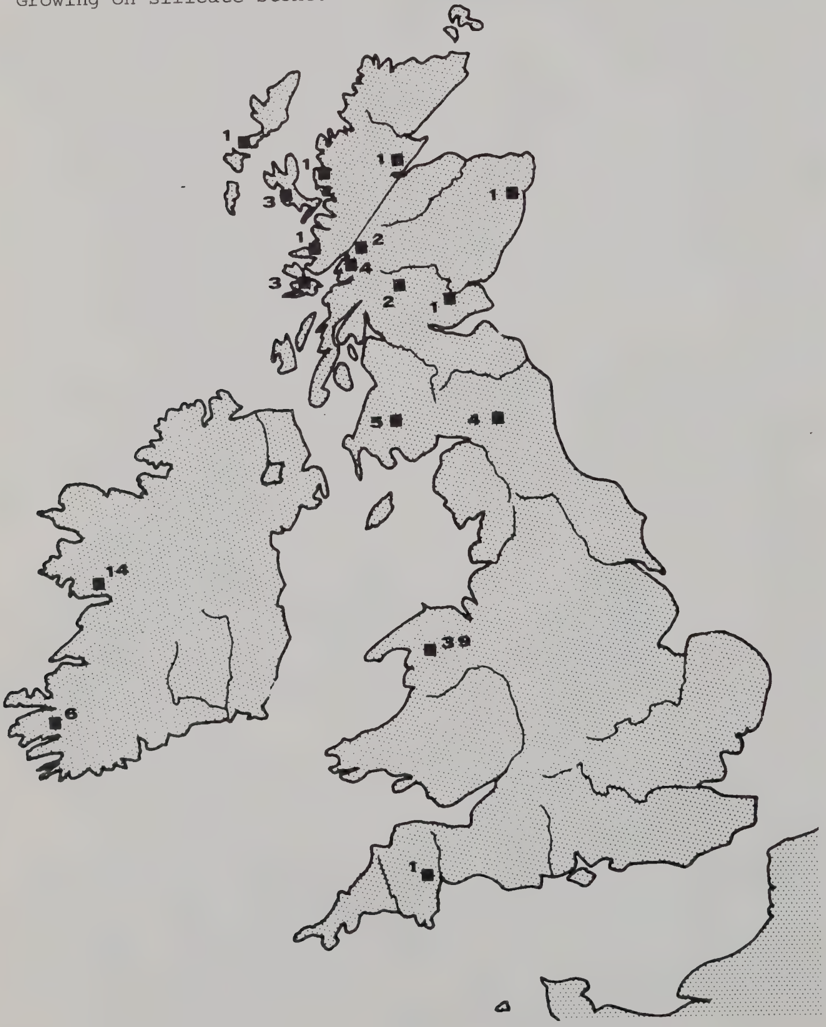
Each mature pseudopodetium nearly always bears a single hemispherical apothecium, c. 1 mm diameter. In some cases two separate apothecia develop at the tip of the pseudopodetium but later merge together. Apothecial margin down turned as far as the point of attachment to the stalk. The boundary between the generative and vegetative tissue arches upwards to form a small columella at the center of the apothecium (fig. 12). The boundary-texture and pigment-boundary between the generative and vegetative tissue are absent in mature apothecia. The development of apothecial primordia, which have a pigment-boundary is very characteristic for the species (Jahns, 1970a).

Hymenium c. 230 µm high, lower part pigmented, margin sterile, consisting only of paraphyses. Excipulum absent. Asci eight-spored. Spores rounded when young, becoming spindle-shaped when mature, 14.0-19.0 x 6.5-8.5 µm. The brown-black pigment is densest directly below the paraphyses and tends to become less intense towards the columella.

Phycobiont green, *Pleurococcus* type, cells c. 8 µm diameter.

Cephalodia brown, granular, surface irregular and lumpy, containing *Stigonema*. The development of the cephalodia was described elsewhere (Jahns, 1972).

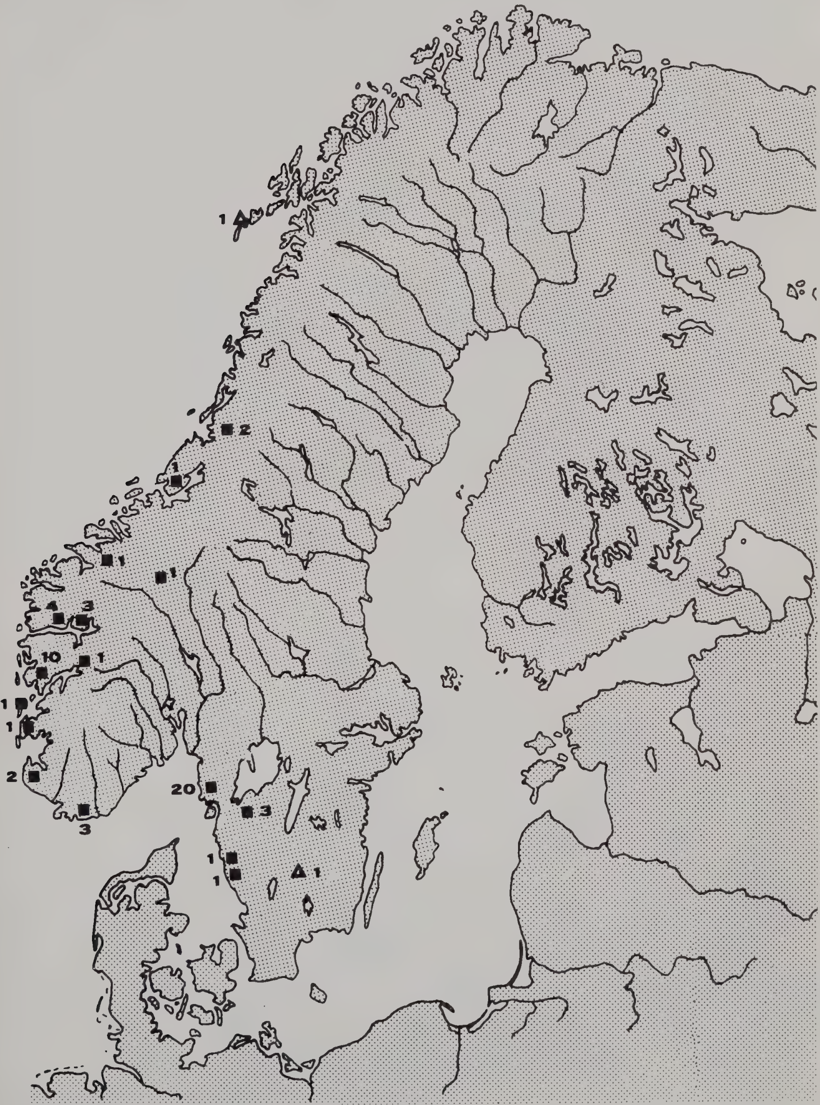
Growing on silicate stone.



map 12 *P. strumaticus* - distribution in Great Britain

Remarks

The distinct columella in the apothecium is characteristic of mature specimens of this species, distinguishing them from the other small species. *P. robustus* the only other species with a columella, has a distinctly different habit.



map 13 *P. strumaticus* - distribution in Scandinavia (■ places not listed in the description, ▲ specimens not examined)

The name *P. strumaticus* was first used by Crombie (1875, p. 140), but as no description was appended it was a nomen nudum there.

Distribution (map 12-13)

P. strumaticus has been found in western Scandinavia and in Great Britain. In contrast to *P. robustus* and *P. cereolus*, this species obviously prefers an oceanic climate and extends far less to the east and north of Scandinavia than the other two species. Similar observations were made by Ammann and Ammann (1969). Two of their locations have been included in map 13 (marked by a triangle), without having been examined by me.

Pilophorus vegae Krog, Norsk Polarinstitutt Skrifter, 144: 56-57, Oslo (1968), fig. 14. Type collection: Alaska, Bering Sea district, Nunivak Island, Roberts Mt., 1700 ft, Krog (O, holotype).

Thallus horizontalis crustaceous, consisting of loosely aggregated or nearly evanescent granules, c. 0.5 mm diameter, white when dry. Pseudopodetia simple or branched in the upper part. Branches either dichotomous or irregularly bush-like. Pseudopodetia 1.0-1.5 cm high and c. 3 mm broad. Younger parts covered with a continuous algal layer, consisting of minute granules or scales. Color of scales white, later becoming blackened at the base of the pseudopodetia. Basal part of old pseudopodetia often ecorticate. Central column of the young stalks hyaline, while the interior of older stalks is completely black.

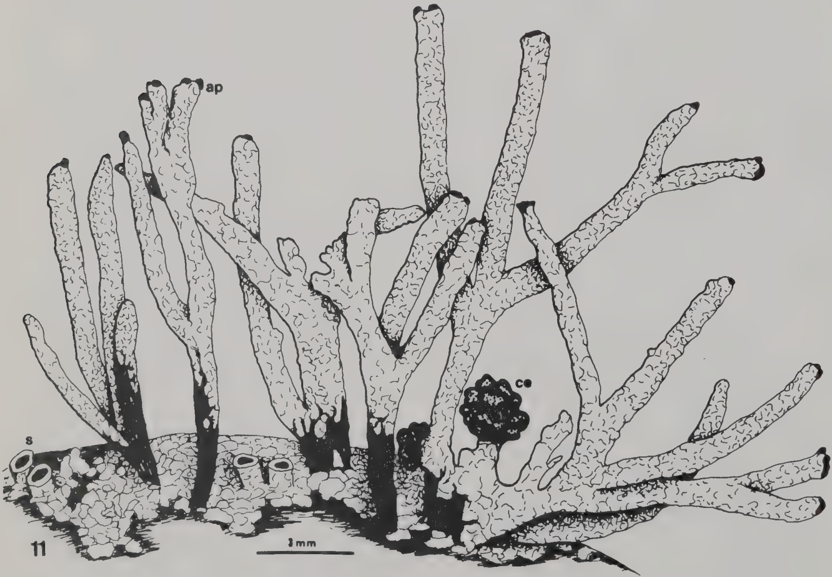


fig. 11 *P. vegae* (ap - primordium of apothecium, ce - cephalodium, s - broken stalk with pigmented center)

Pycnidia not observed.

Mature apothecia are absent in all specimens examined, but primordia of apothecia are found terminal at the tip of the stalks.

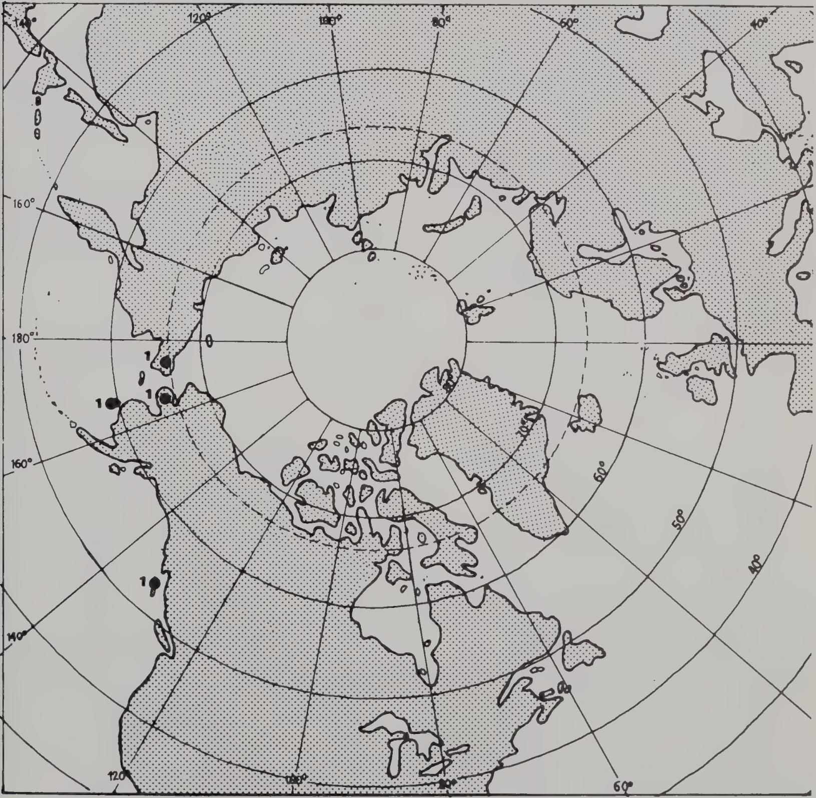
Phycobiont green, *Pleurococcus* type.

Cephalodia stipitate on the pseudopodetia (fig. 11), containing *Nostoc* in the type-specimen and *Stigonema* in other specimens. Small cephalodia-like structures on the substrate contained algae of the *Gloeocapsa* type, but it seems doubtful, whether they belong to this lichen.

Growing on silicate rock.

Remarks

P. vegae can be confused with *P. robustus* and *P. acicularis* occurring in the same region. The clearest characteristics of the species, which are lacking in *P. robustus* and *P. acicularis*, are the white color of the young pseudopodetia and the black pigment of the central column. *P. nigricaule*, which also has a white cortex and a black central column is smaller and easily recognized by the globular or peltate shape of its cortex granules.



map 14 *P. vegae* - distribution (● places listed in the description of the species)

Distribution (map 14)

P. vegae is known from Alaska and the Bering Strait area only. I have seen the following specimens:
USSR, Tschuktschorum, Bovidential, 64°45'N, 174°W (2 specimens LE, O); USA, Alaska, Bering Sea district, Nunivak Island, Roberts Mt., 1700 ft(O); USA, Alaska, Central Pacific Coast, Talkeetna Mts. (O); Canada, British Columbia, Queen Charlotte Islands, Moresby Island, Laing Point Mountain, SE of road into Peel inlet, c. 1 mile of Laing Point, 2000 ft (CAN).

Lichens to be excluded from the genus Pilophorus

Four species have been described as belonging to the genus *Pilophorus*, which must be placed elsewhere:

Pilophorus colensoi (Bab.) Knight, Trans. Proc. New Zealand 16: 400 (1884).
Stereocaulon colensoi Bab., in Hooker, Flora N.Z. 2: 294 (1867).
Type collection: New Zealand, Colenso 2746 (BM, holotype).
Corynophoron colensoi (Bab.) Nyl., Lich. Nov. Zeland.: 15 (1888).

Thallus horizontalis thin, granular and evanescent. Pseudopodetia up to 5 mm high, branched. Cortex of irregular scales. Cephalodia sacculate, on the pseudopodetia, containing *Stigonema*. Development of apothecia following the typical ontogeny of a *Stereocaulon* species (Jahns, 1970a).

Remarks

The helical ascogones are especially typical and quite different from the straight ones found in the genus *Pilophorus*. The species therefore belongs to the genus *Stereocaulon*, a view also taken by Th.Fries (1857) and by I.M. Lamb in a note attached to the type-specimen.

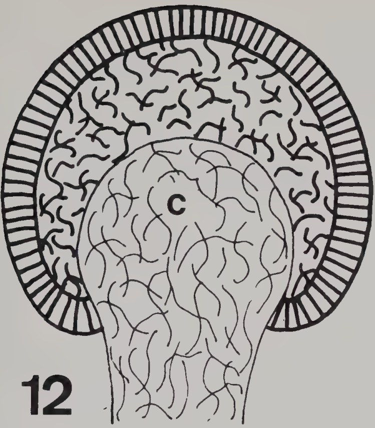
Räsänen (1932, p. 24) described *P. colensoi* var.*reagens* Räs. from Tierra del Fuego.

I have seen material from the following places:
New Zealand, Colenso 2746 (BM, holotype); Fuegia occid. supra Rupium (B); N-East of New Zealand (G).

Pilophorus conglomeratum F.Wils., Linn. Soc. Journ. Bot. 28: 372 (1891). Type collection: Hab. supra truncum arboris smortuum muscosum in Black spur. Victoria, Australia (BM, holotype).
Pilophorus cariosum Hue, Nouv. Arch. Mus. 3, 10: 280 (1898).

Thallus horizontalis thin, grey-green, consisting of minute granules up to 0.1 mm in diameter. Thallus horizontalis persistent or evanescent. Thallus verticalis up to 2 cm high, pin-like, unbranched. In young specimens more or less smooth, covered with a thin layer of minute granules similar to those forming the thallus horizontalis. Thallus verticalis quickly becoming bare and divided by lengthwise-oriented furrows. In old specimens the stalk consists of numerous nearly-separated columns.

fig. 12-16 anatomy of apothecia (bt - boundary-texture, c - columella, pb - pigment-boundary)
fig. 17 *P. nigricaule* with peltate scales, longitudinal section of the stalk



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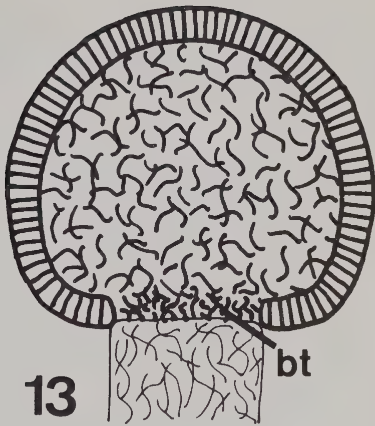

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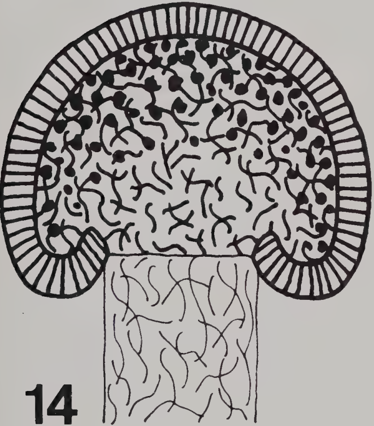

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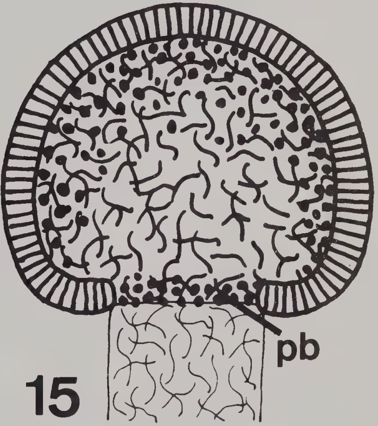

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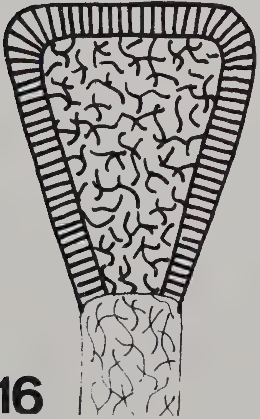

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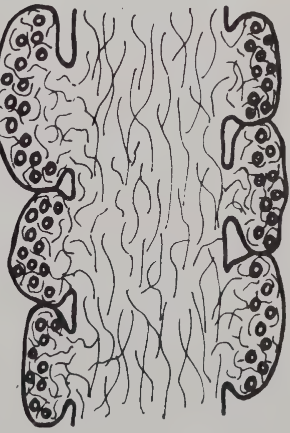

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Several small apothecia crowded at the tip of the stalks, gradually merge into one large fruitbody. Spores 14 x 3.5 µm, spindle-shaped. Apothecia dark-brown. Cephalodia absent.

Remarks

The species somewhat resembles *P. robustus*, but the absence of cephalodia and the brown pigment of the apothecia are striking differences. The whole habit is slightly different from a *Pilophorus* and therefore the species should be excluded from the genus. Perhaps the lichen is related to *Baeomyces* or to one of the genera of the Cladoniaceae (e.g. *Heteromyces, Thysanothecium*) but the question can not be settled before more is known of its ontogeny.
I have seen material from the following places:
Tasmania, Hartz Mountain plateau, on rotten wood in forest, extremely damp and well shaded, alt. 3700 ft (BM); Central Western Tasmania, forest at western side of Mt. Arrowsmith near Franklin River, (BM); North Western Tasmania, Ball Room Forest Track, Dove Lake, near Cradle Mt. (BM); New Zealand, South Island, Fjordland, Eglinton Valley, Cascade Creek, alt. 1600 ft (BM); Victoria, Australia (BM, holotype).

Pilophorus staufferi Frey (nomen nudum), Bot. Jahrb. 86, 1-4: 242 (1967). Type collection: Neukaledonien, Monts des Koghis, Mt. Bono, Gipfelgrat, 1070 m (BERN).

One's first impression of this species is that it is very much like *P. robustus*. The thallus verticalis is umbellately branched in the upper part, each branch bearing one to several apothecia. But on close inspection the lichen seems to be related to *P. conglomeratum*. The color of the apothecium is more brown than black, and the stalks show the same furrows as in *P. conglomeratum*. Cephalodia are also absent. The thallus horizontalis of *P. staufferi*, unlike the granulated thallus of *P. conglomeratum*, consists of small phylocladia about 1 mm in diameter. I think that *P. staufferi* and *P. conglomeratum* belong to the same genus; their exact taxonomic positions must be decided later.

Pilophorus pileatum (Mont.) Zahlbr. (nomen nudum), Catal. Lich. 10: 381 (1939).
Cladonia pileata Mont., Annal. Scienc. Nat. Bot. 3, 18: 310 (1852) Type collection: Coquimbo in Chile.

I have seen no samples from this species, but the descriptions of Montagne (1852) and Vainio (1887) mention brown-black apothecia. Therefore it certainly does not belong to *Pilophorus*.

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NEW DEMATIACEOUS HYPHOMYCETES FROM TROPICAL RAIN FOREST LITTER

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Summary

In this paper, a new genus, Chryseidea gen.nov. with the new species C.africana, and two new species, Beltrania onirica sp.nov. and Phaeotrichoconis aurata sp.nov., from Tai National Park (Ivory Coast) forest litter, are described.

Among mycological investigations carried out by this Chair on the Tai project (M.A.B., Project n.1) to study the influence of human activities on the south-west forests in the Ivory Coast and with the purpose to improve the environmental knowledge and quality, three new species and a new genus of Dematiaceous Hyphomycetes are described. They were found on dead leaves collected on the soil surface in the Tai National Park forest. Every attempt at isolation in pure culture was unsuccessful. The following descriptions concern observations on natural media.

Exsiccata are available in the Mycological herbarium of the Rome Botanical Garden, (RO).

Chryseidea Onofri gen.nov.

Conidiophora macronematosa, synnematosa, erecta, simplicia, pigmentata, in apice semper sterilia. Cellulae conidiogenae a latere positae, determinatae, discretae, simplices, ampulliformes, apice denticulato, circiter in medio synnemati circumpositae. Conidia hyalina, falcata.

Sp.typ.: C.africana Onofri sp.nov.

Conidiophores macronematous, synnematous, straight, simple, pigmented, with apices always sterile. Conidiogenous cells lateral, determinate, discrete, simple, ampulliform, with a denticulate apex, surrounding the conidiogenous apparatus approximately in the mid part. Conidia hyaline and falcate.

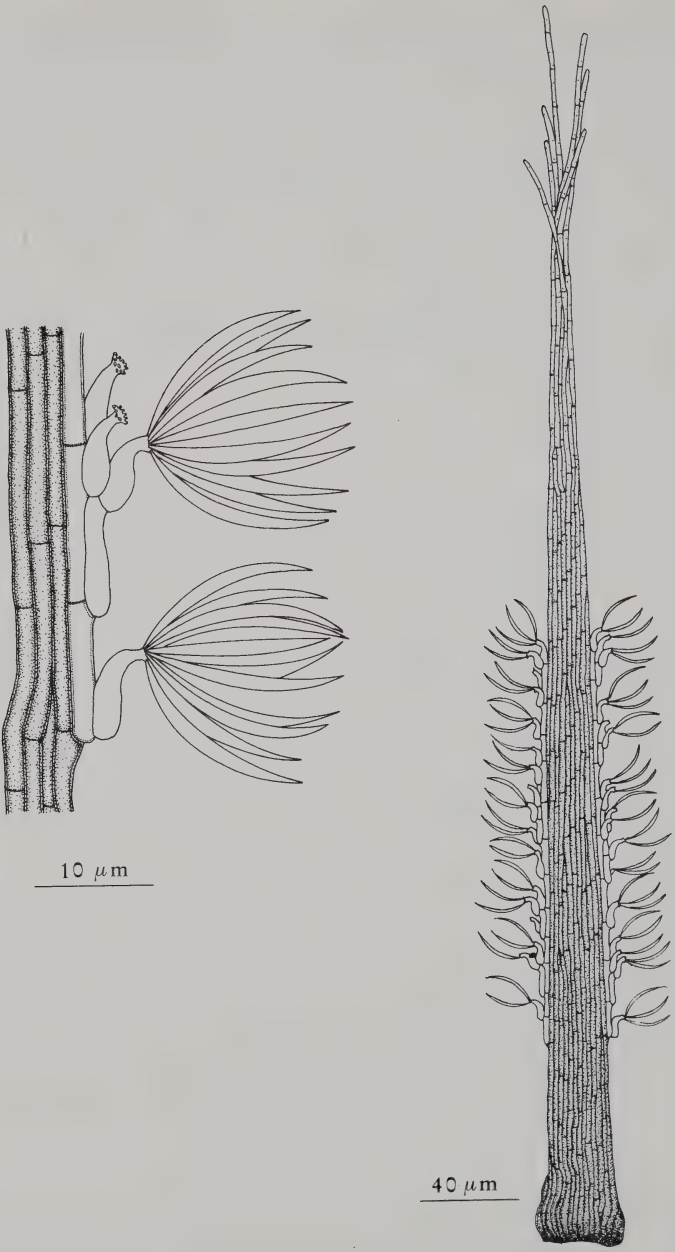

Fig. 1 - Chryseidea africana gen. et sp.nov.: a. conidiophore; b. conidiogenous cells with conidia.

Chryseidea *africana* Onofri sp.nov.

Conidiophora macronematosa, synnematosa, solitaria, recta, simplicia, adtenuato et sterili apice, ex constantibus et rectis hyphis (2 μm crassis) composita, pallide brunnea, usque ad 560 μm longa et 42 μm ad basim crassa. Cellulae conidiogenae a latere positae, discretae, simplices, ampulliformes, cum apice saepe deflectens conidiorum forsitan pondere vel magna copia et denticulato ob subsequentes locorum qui conidia generant proliferationes; orientes ex hyphis lateralibus, adherentibus et parallelis ab hyphis synnematis et orientibus proxime sub saeptis; ab circiter tertio altitudinis a basi usque ad dimidium synnema circumpositae, sufflavae; 7,8-11,2x2,3-2,7 μm. Conidia falcata, asaeptata, extremitatibus acuta, hyalina, omnia agglutinata; circum conidiophora permanent in formam similia *Chaetopsina* *fulva*; 14,5-18,5x1,4-1,9 μm.

In foliis emortuis, Tai, Ora Eboris, holotypus: H.B.R. 116A, (RO).

Conidiophores macronematous, synnematous, solitary, straight, simple, narrowing to the sterile apex, composed of straight and regular hyphae, Ochraceous-Tawny in colour (Ridgway, 1912), up to 560 μm long and 42 μm thick at the base. Conidiogenous cells lateral, discrete, simple, ampulliform and denticulate from successive proliferations, with the apex frequently repent, presumably under the weight of conidial production; they originate from lateral hyphae that grow just under the septa of conidiophorous apparatus at about one third of the height from the base and extend up to half of the height of the conidiophorous apparatus, along which they grow side by side, Light-Buff in colour (Ridgway, 1912); 7,8-11,2x2,3-2,7 μm. Conidia 0-septate, falcate, with very sharp apices, hyaline, 14,5-18,5x1,4-1,9 μm; they remain coiled at the apex of each conidiogenous cell in a compact mass surrounding the conidiophorous apparatus.

The microorganism described presents morphological characters different from others belonging to genera with synnematous conidiophorous apparatus. It differs in the position of the conidiogenous cells along the conidiophorous apparatus, in the resulting general structure (*Chaetopsina* like) and in spore shape. For these considerations we think necessary to propose the new genus, *Chryseidea*, and the species *C. africana* for our strain.

Beltrania *onirica* Lunghini sp.nov.

Coloniae effusae. Mycelium immersum. Setae erectae, simplices, leves, atrobrunneae, usque ad 506 μm longae et 4,6 μm ad basim crassae. Conidiophora macronematosa, mononematosa, simplicia aut rarius ramosa, saeptata, flexuosa, levia, non constanti crassitudine, pallide brunnea, 184-236x4,6 μm; ab eadem basi setarum oriuntur. Cellulae conidiogenae integratae, terminales, polyblasticae, denticulatae, sym-

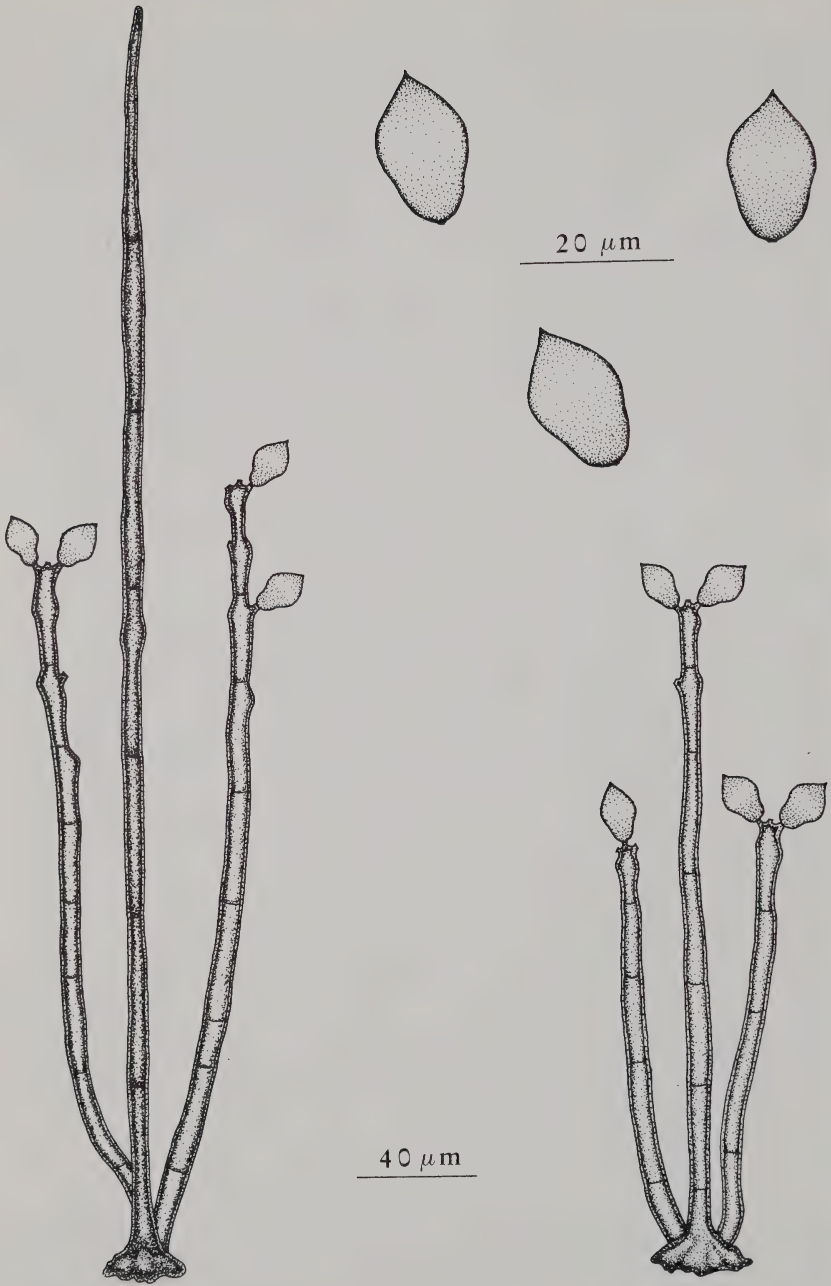
20 μm
40 μm

Fig. 2 - Beltrania onirica sp.nov.: a. conidiophores; b. conidiophores and seta; c. conidia.

podiales, locis qui conidia generant magno intervallo positis, pallide brunneae. Conidia levia, acrogena, protoplasmate granuloso, solitaria, conica-campanulata, zona supraaequatoriali subhyalina et tenui ornata, ad basim denticulata, ad apicem breviter appendiculata, pallide brunnea; 19-21x11,5-12,5 μm; appendix circiter 2 μm longa.

In foliis emortuis, Tai, Ora Eboris, holotypus: H.B.R. 117A, (RO).

Colonies effuse. Mycelium immersed. Setae straight, simple, with thick and smooth walls; Argus Brown in colour (Ridgway, 1912); length up to 506 μm and 4,6 μm thick. Conidiophores macronematous, mononematous, simple or rarely branched, septate, slightly curved and irregulary thick, Deep Olive-Buff in colour (Ridgway, 1912), 184-236 x4,6 μm; originating from the base of the seta. Conidiogenous cells integrated, terminal, polyblastic, denticulate, elongating by sympodial proliferation, Deep Olive-Buff in colour (Ridgway, 1912). Conidia smooth, acrogenous, with granular protoplasm, solitary, conic-campanulate, with a thin, not easily observed transverse band, with a very short appendage at the apex and denticulate at the base, Deep Olive-Buff in colour (Ridgway, 1912); 19-21x11,5-12,5 μm; appendage about 2 μm long.

The microorganism described presents characters different from those of related species. In particular it differs from Beltrania querna Harkness (Pirożynski, 1963) with conidia with a different shape and longer appendage; the conidial shape of our strain is very close to those of B. mangiferae Munjal et Kapoor (Pirozynski and Patil, 1970) and B. muelleri Rao et Mani Varghese, 1978, but these species are characterized by different conidiogenous cells. For these considerations we propose the new species B. onirica for our strain.

Phaeotrichoconis aurata Rambelli sp.nov.

Coloniae effusae. Mycelium immersum. Conidiophora macronematosa, mononematosa, solitaria, erecta, simplicia, saeptata, levia, brunnea-sufflava, usque ad 126 μm longa et 3,6-5 μm crassa (ad basim 8-10 μm). Cellulae conidiogenae polytreticae, integratae, sympodiales, cicatricibus conidialibus parum manifestis preditae. Conidia solitaria, sicca, acrogena, obclavata, 5-saeptata, ad basim trunca, ad apicem longo rostro praedita, levia, pallide brunnea-flava, protoplasmate omogeneo; 34,5-43,7x4,6-6,9 μm; rostrum rectum, asaeptatum, hyalinum, usque ad 25 μm longum et usque ad 2 μm crassum.

In foliis emortuis, Tai, Ora Eboris, holotypus H.B.R. 118A, (RO).

Colonies effuse. Mycelium immersed. Conidiophores macronematous, mononematous, solitary, straight, simple, septate, with smooth walls, Buffy Brown in colour (Ridgway, 1912), up to 126 μm long and 3,6-5 μm thick (8-10 μm at the base). Conidiogenous cells polytretic, integrated, sympodial. Conidia solitary, dry, acrogenous, obclavate, transversely

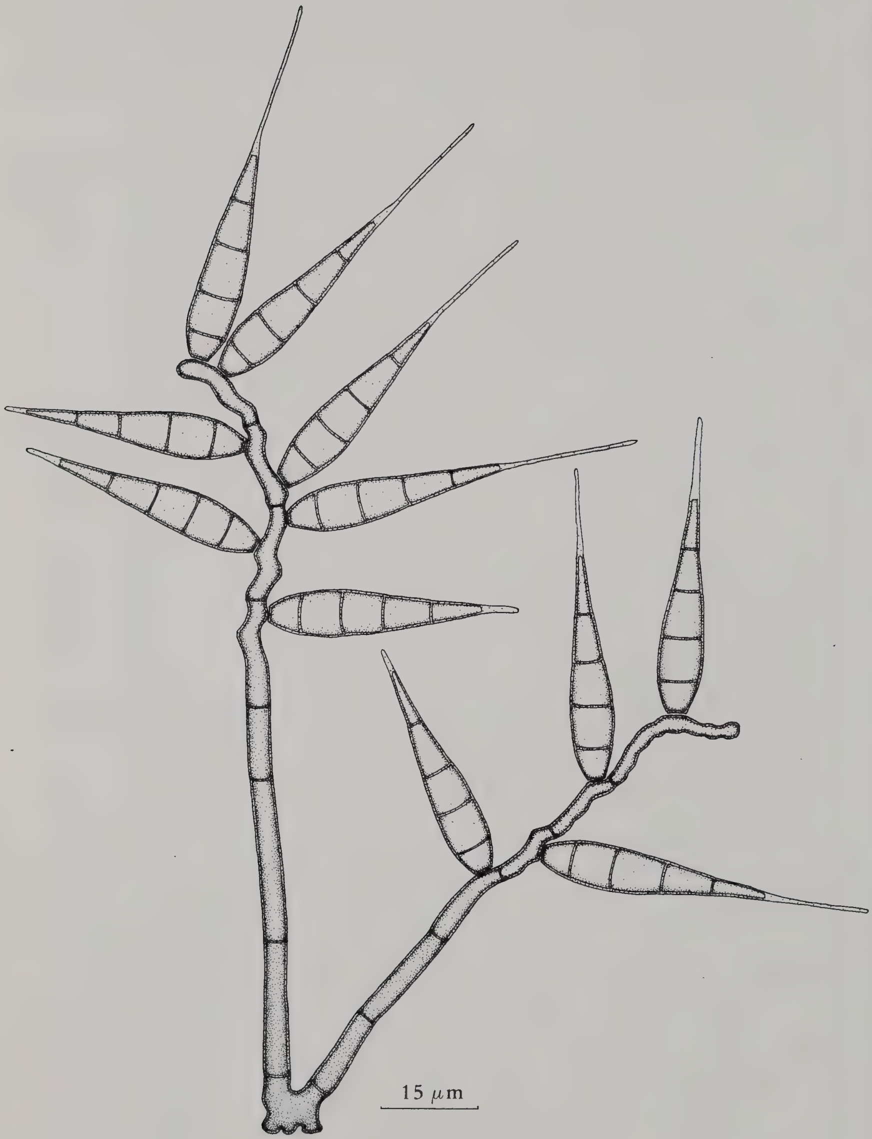

Fig. 3 - Phaeotrichoconis aurata sp.nov.: conidiophores with conidia.

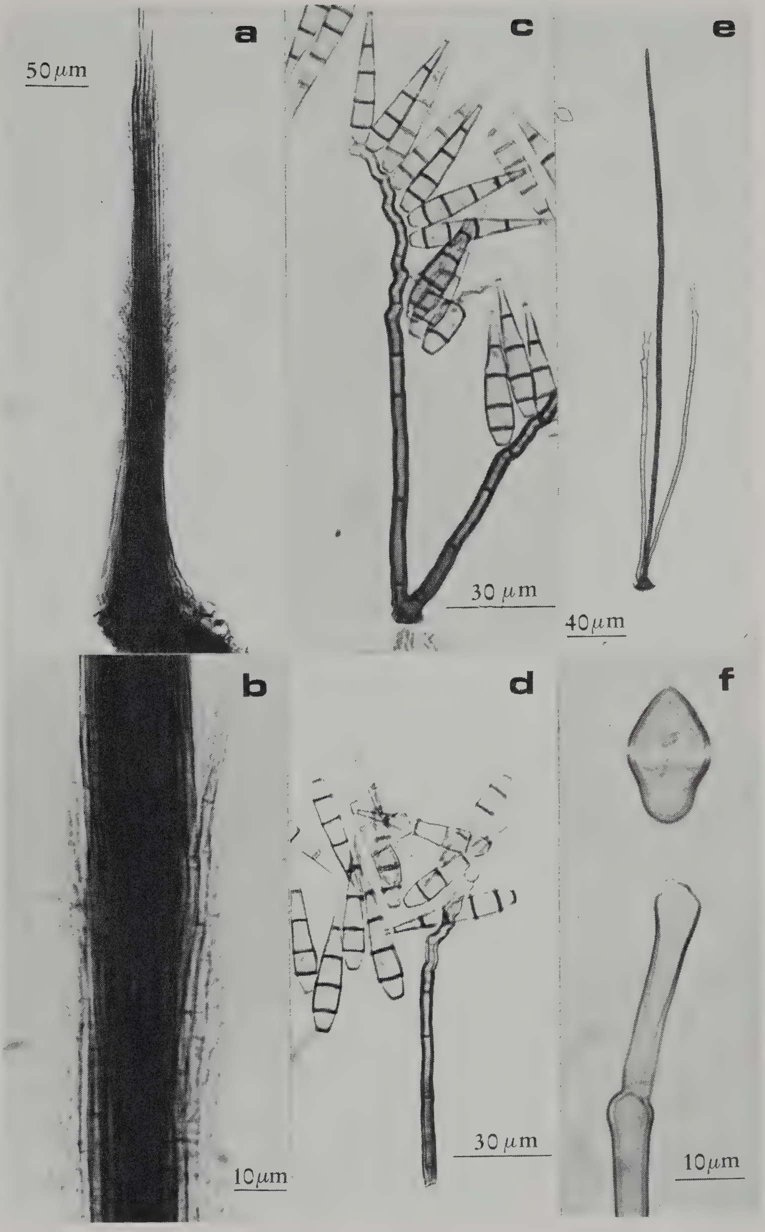
a
50 μm
c
30 μm
e
40μm
b
10μm
d
30 μm
f
10μm

Fig. 4 - Chryseidea africana: a. and b.
Phaeotrichoconis aurata: c. and d.
Beltrania onirica: e. and f.

5-septate, rostrate, with a large scar at the base, smooth, Tilleul-Buff in colour (Ridgway, 1912), with homogeneous protoplasm, 34,5-43,7x4,6-6,9 μm; scar about 2,5-3 μm wide, beak straight, aseptate, hyaline, up to 25 μm long and 2 μm thick.

Ellis (1971) modified the original diagnosis of the type species *P. crotalariae* (Salam et Rao) Subramanian to include also species characterized by polytretic, integrated, terminal and sympodial conidiogenous cells. Our microorganism seems includable in the genus *Phaeotrichoconis* as modified by Ellis (1971), but differs from the two described species, *P. crotalariae* and *P. urariae* Bharadway, in several characters and mainly in the dimensions; for these reasons we propose for our strain the name *P. aurata* as a new species.

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COCHLIOBOLUS RAVENELII SP. NOV. AND *C. TRIPOGONIS* SP. NOV.

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Abstract

Cochliobolus ravenelii sp. nov. and *C. tripogonis* sp. nov. are described from culture, as the teleomorphs for *Bipolaris ravenelii* and *B. tripogonis* comb. nov. respectively.

As part of a study of generic concepts in the complex of fungi assigned to *Drechslera* sens. lat., I have attempted to produce teleomorphs for species where no such connection was known. This has been done to test the hypothesis that conidial state characters allow prediction of teleomorph correlations, and that new associations will prove to be *Drechslera* sens. str. - *Pyrenophora*, *Bipolaris* - *Cochliobolus*, and *Exserohilum* - *Setosphaeria* (Luttrell 1977, 1978). Three new teleomorphs were described previously, two in *Cochliobolus* (Alcorn 1978a) and one in *Setosphaeria* (Alcorn 1978b), and those results support the predictive aspect of anamorph classification. Subsequently *Cochliobolus* states have been induced to form in cultures of other species. Two of these teleomorphs are described here as new.

COCHLIOBOLUS RAVENELII

Ascal states in *Cochliobolus* were found by McKenzie (1968) for two '*Helminthosporium*' species which infect *Sporobolus* inflorescences in Queensland. The work was reported in a thesis, and subsequently none of the data presented have been published. McKenzie did not assign specific epithets to the *Helminthosporium* collections studied. I have examined specimens she deposited in BRIU and there is no doubt that one of the anamorphs connected with a teleomorph was *Bipolaris ravenelii* (Curt.) Shoem. Luttrell (1976) was unable to produce a perfect state for this species, and I made many unsuccessful pairings of cultures before a teleomorph developed. The methods used in the successful attempt are described briefly below.

Ten collections of *Sporobolus* spp. with infections of the inflorescence caused by *B. ravenelii* were made in south-eastern Queensland, in an area approximately 60 km north of Brisbane. Conidia from each of five panicles in each collection were streaked over water agar plates and allowed to germinate. Four germinated conidia from each plate were transferred to PDA, making a total of 20 transfers for each collection. Cultures were paired on Sach's agar (Hebert 1971), each plate being amended with maize leaf and barley grain. Three methods of pairing were employed:

A. Bulked conidial inoculum was prepared for each collection. Conidial suspensions from all isolates from a single collection were mixed and inoculated onto the plates.

B. All possible pairings between collections were made, using the bulked conidial inoculum from each.

C. All possible pairings between collections, using one single-conidium isolate from each. Inoculum consisted of blocks from PDA cultures.

Ascocarps were obtained in only one pairing, namely with bulked inoculum from collection 7957 (*Sporobolus fertilis* (Steudel) W.D. Clayton, Glasshouse Mountains, 24.v.1979) and collection 7963 (*S. elongatus* R. Br., Maleny, 24.v.1979). Four ascocarps were formed, each with a globose basal body and a long cylindrical neck. They were visible only because the necks projected above the dense hyphal mat investing the basal section. Ascocarps contained many ripe asci which released ascospores freely in water. Single-ascospore cultures were established. These cultures were paired in all possible combinations, but only one pairing resulted in the formation of ascocarps. None were formed in single-ascospore cultures, but all produced an anamorph on PDA indistinguishable from *B. ravenelii*.

In another test, small numbers of ascomata formed in pairings of cultures from collections 7976 (*S.? fertilis*, St. Lawrence, 24.vii.1979) and 7977 (*Sporobolus* sp., Clairview, 24.vii.1979), and 7976 and 7978 (*S. fertilis*, between Sarina and Mackay, 24.vii.1979). Some single-ascospore isolates from these ascocarps produced the teleomorph when paired, but not when grown alone under the same cultural conditions. Subsequently ascomata were formed in greater numbers when inflorescences and grain of *S. elongatus* were used as the plant substrate in Sach's agar plates, instead of maize leaf or barley grain.

Cochliobolus ravenelii sp. nov. Figures 1 - 4

Ascocarpi atrobrunnei vel atri, basi globosa 360-515 µm diam. et collo cylindrico 980-1800 µm alto, ad basim 95-135 µm diam., ad apicem 95-115 µm diam. Asci cylindrici, vestigiales bitunicati, 185-300 x 14-17.5 µm. Ascosporae hyalinae, filiformes, versus extrema angustatae, rectae vel torsivae, 5-14-septatae, 155-310 x 5-7.5 µm.

In inflorescentiis et granis *Sporoboli elongati* in agaro Sachii, vii. 1980, BRIP 13165, holotypus; BRIP 13027, 13028 paratypi.

Ascocarps dark brown to black with a globose body 360-515 µm diam. and a paler cylindrical neck 980-1800 x 95-135 µm at the base and 95-115 µm at the apex; occasionally with a cylindrical base up to 280 µm x 250 µm below the ascogenous section. Ascocarp body often covered densely by reddish brown hyphae, the beak glabrous or with a few short hairs (Fig. 1). Asci cylindrical, usually tapered slightly near the base but lacking a distinct pedicel, straight or curved, 185-300 x 14-17.5 µm, often with a blunt bifurcate foot 6-10 µm diam., vestigial bitunicate (Fig. 2). Ascospores filiform, straight or coiled helically in the ascus, slightly tapered to obtuse apex, more so to base, 5-14-septate, 155-310 x 5-7.5 µm (Fig. 3).

In some asci the degree of ascospore coiling is only very slight, while in others it is more pronounced. Sometimes ascospores are tightly coiled in the apical part for 20-25 µm, and loosely in the remainder. Ascospore diameter at the apex is about 4 µm, and at the base 2.5 µm. Conidia from two collections which gave rise to inter-ferile cultures of *B. ravenelii* are illustrated in Figure 4.

Cochliobolus ravenelii is quite distinct from *C. sporoboli* Castellani, which occurs on *Sporobolus* leaves (Castellani 1951). *C. sporoboli* has smaller, short-beaked ascomata, smaller asci, and shorter 4-6-septate ascospores.

COCHLIOBOLUS TRIPOGONIS

Drechslera tripogonis A.S. Patil & V.G. Rao was described from India, infecting the inflorescences of *Tripogon jacquemontii* Stapf (Patil & Rao 1972). Subsequently I collected a similar fungus on *T. loliiformis* (F. Muell.) C.E. Hubbard in Australia (Yetman, New South Wales, 12.v. 1977, J.L.A. 77158). Comparison with the type specimen (IMI 161251) showed that the fungus on this host was conspecific with *D. tripogonis*. No other collections have been made, although *T. loliiformis* has been examined at three other sites in Queensland (Bunya Mountains, Cooroy, Peregian Beach). Herbarium specimens of this species in BRI, from many different localities in eastern Australia, were also searched. No infections of the inflorescence were detected.

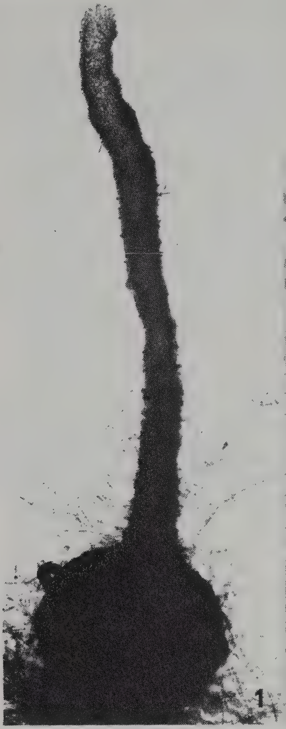
Single-conidium isolates from the collection on *T. loliiformis* were paired. A teleomorph referable to the genus *Cochliobolus* developed in these paired cultures. Single-ascospore isolates sometimes formed ascomata when paired, but never when grown alone. The anamorph formed by single-ascospore cultures is indistinguishable from that produced by the original single-conidium isolates.

Cochliobolus tripogonis sp. nov. Figures 5 - 8

Ascocarpi atri, basi globosa 300-590 µm diam. et collo cylindrico 880-2000 x 50-150 µm. Asci cylindrici, vestigiales bitunicati, 170-310 x 12.5-18.5 µm. Ascosporae hyalinae, filiformes, versus extrema angustatae, torsivae, 4-9-septatae, 175-275 x 4-6 µm.

Figs. 1 - 4 *Cochliobolus ravenelii* (1) Ascocarp x50 (2) Asci x200 (3) Ascospores x320 (4) Conidia from collections 7957(a) and 7963(b), x320. Isolates from these collections formed the teleomorph of *C. ravenelii* when paired.

Figs. 5 - 8 *Cochliobolus tripogonis* (5) Ascocarp x50 (6) Ascus x320 (7) Ascospore x320 (8) Ascosporic chlamydospores x320.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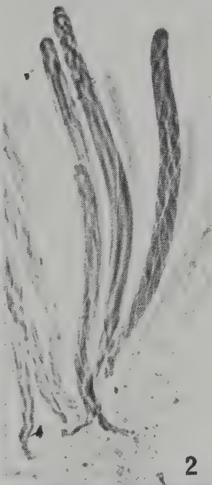
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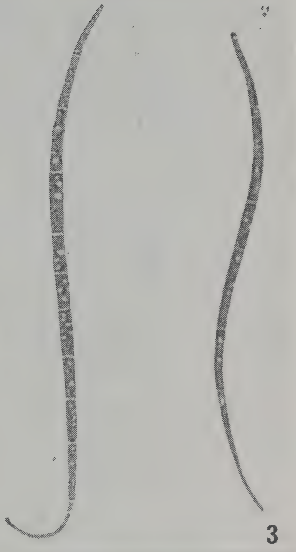
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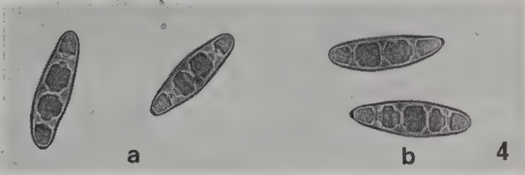

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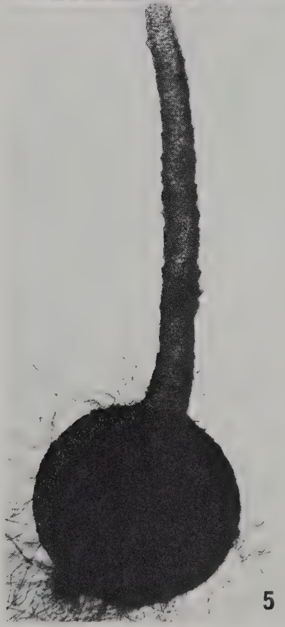
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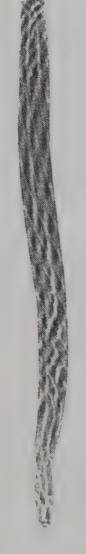
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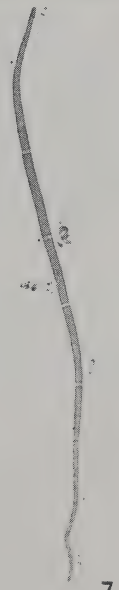
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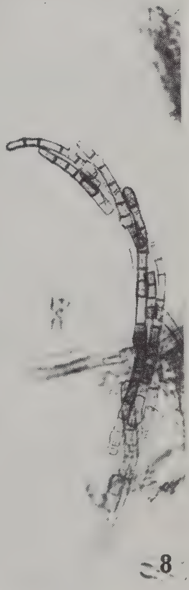
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In foliis *Zeae maydis* in agaro Sachii, ix. 1977, BRIP 12375, holotypus; BRIP 12273 paratypus.

Ascocarps black, with a globose basal part 300-590 µm diam. bearing a long, straight or slightly curved cylindrical neck 880-2000 x 50-150 µm (Fig. 5). Conidiophores are not formed on ascocarp body or neck. Asci cylindrical, vestigial bitunicate, slightly tapered near the base, 170-310 x 12.5-18.5 µm (Fig. 6). Ascospores filiform, hyaline, helically coiled in the ascus and completely filling it, commonly somewhat loosely coiled in the median section and more tightly in the extremities, gradually tapered to approximately half the maximum width at each end, 4-7-septate, 175-275 x 4-6 µm (Fig. 7).

Single cells of some ascospores become dark brown and thick walled, while retaining their original shape (Fig. 8). These darker cells are regarded as ascosporic chlamydospores. I am unaware of any other reports of this phenomenon in *Cochliobolus* species.

In additional testing, inflorescences of *T. loliiformis* on Sach's agar were used as the substrate in an attempt to produce greater numbers of ascocarps. Ascomata were formed on the rachis and florets, but no more abundantly than previously. In some, a basal pedicel 30-150 µm high and 30-58 µm diam. was present below the swollen fertile section of the ascocarp.

The teleomorph of *C. tripogonis* is distinct from that of most other *Cochliobolus* species because of the very long ascocarp neck. Species such as *C. cymbopogonis* J.A. Hall & Sivanesan, *C. hawaiiensis* Alcorn, and *C. ravenelii*, which also have ascomata with long necks, can be distinguished by other morphological characteristics of teleomorph and anamorph.

Evidence supporting recognition of *Bipolaris* as a genus distinct from *Drechslera* will be presented elsewhere. Part of that evidence relates to *D. tripogonis*, for which a new combination is necessary.

Bipolaris tripogonis (A.S. Patil & V.G. Rao) comb. nov.
Drechslera tripogonis A.S. Patil & V.G. Rao, 1972, Trans. Br. mycol. Soc. 59: 340.

Single-ascospore cultures representing opposite mating types of both *Cochliobolus* species have been deposited in the culture collection of the Commonwealth Mycological Institute (IMI 255652 and 255653, *C. ravenelii;* IMI 235294 and 235295, *C. tripogonis*).

ACKNOWLEDGEMENTS

I am grateful to Dr R.F.N. Langdon (BRIU) and Dr B.C. Sutton (IMI) for lending specimens in their keeping, and to Mr R.G. O'Brien for assistance in obtaining some of the *Bipolaris ravenelii* collections.

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A PSYCHOTROPIC FUNGUS IN NEPAL

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SUMMARY

The presence of a Psilocybe species in Nepal which is close to P. cubensis (Earle) Sing. or P. subcubensis Guzmán and of known psychoactive properties is discussed. This is the first report of a bluing Psilocybe in the mailand Asia. Speculations on probable early cultural use of this and other Psilocybe in South Asia is also presented.

During 1978 and 1979 Schroeder have been working as an applied anthropologist for Rockefeller Foundation in agricultural development in Nepal. On a field trip to Pokhara in early 1978 he became aware of a bluing species of fungus. Collections of the species were made in the Pokhara valley over a two year period. Although actual specimens were not sent to Guzmán, for customs problems, the Nepal species was positively identified by him as either Psilocybe cubensis (Earle) Sing., or Psilocybe subcubensis Guzmán on the basis of a set of color photos of the collections made by Schroeder. These two species are both bluing and psychoactive; both exist in Mexico, and both are used by Mexican Indians. They differ in that P. cubensis has larger spores, and P. subcubensis has smaller spores, as discussed Guzmán (1978). On the other hand, P. cubensis is more common in subtropical regions, whereas P. subcubensis occurs commonly in tropical regions.

This appears to be the first documented report of a psychoactive Psilocybe species in mainland Asia, except the reports from Sri Lanka (Ceylon) by Berkeley and Broome in the last Century, which refer to three species of Psilocybe (These were recently studied by Guzmán in preparation of a monograph on the *Psilocybe*). Other species of *Psilocybe* have been reported by Singer & Smith (1958) from Java and by Imazeki & Hongo (1957, 1969) from Japan. Recently Guzmán & Horak (1978) described six probable hallucinogenic species from New Guinea, New Caledonia and New Zealand, and Guzmán & Watling (1978) reported four bluing species from Australia and Tasmania. Guzmán (in Guzmán & Vergeer, 1978) reported on *Agrocybe tibetensis* (Mass.) Guzmán, a species described by Massee as *Psilocybe* from Tibet in 1906.

The valley in which the Nepal mushrooms were found lies at an elevation of about 2500 feet and is free of frost. The area has a monsoon climate with an average rainfall of about 140 in. per year. Specimens were most commonly found in abandoned fields or fallow fields where cattle and water buffalo were grazed, and in maize fields that had been fertilized with compost. The mushrooms were often growing on partially decomposed cow dung, and were found throughout the year. Peak fruiting occurred following the pre-monsoon rains in May and June, and the mushrooms were least abundant during the winter months.

There is no known local use for the mushroom, nor are psychoactive *Psilocybe* species known to be used elsewhere in South Asia. Western experimenters who have ingested the Pokhara species report experiences similar to those occurring with better known species of *Psilocybe*. Doseage is relatively high with some individuals ingesting forty or more mushrooms.

Wasson and Wasson (1957) described the use of *Amanita muscaria* in Siberian religious ceremonies. Later, Wasson (1972) proposed that *Amanita muscaria* was used by Indo Aryan peoples in the *soma* ritual, which was central to the development of Hinduism. We agree with Wasson that *soma* was a fungus. In light of the discovery of an active *Psilocybe* species in Nepal, however, we suggest that this species, or another yet to be discovered *Psilocybe* species, is the most likely candidate for the *soma* of the Vedas. If this is so, and the soma of the Vedas is both widely distributed and totally unknown in modern South Asia, interesting anthropological questions arise.

AKNOWLEDGEMENTS

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ASCUS STRUCTURE AND FUNCTION IN *COCHLIOBOLUS* SPECIES

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ABSTRACT

Observations by other authors on the structure of asci and mechanism of ascospore release in *Cochliobolus cymbopogonis* are confirmed. Similar structural and functional attributes of asci are found in other *Cochliobolus* species, including the generic type *C. heterostrophus*.

INTRODUCTION

Recently El Shafie and Webster (1980) reported their observations on ascus structure and ascospore liberation in *Cochliobolus cymbopogonis* J.A. Hall & Sivanesan. This novel method of spore release was discovered independently by the writer (Alcorn 1980), and previously unpublished material is presented here.

REVIEW OF LITERATURE

Luttrell (1965) included *Cochliobolus* in the Loculoascomycetes, but noted that asci in this genus appeared to be unitunicate. The ascus in *C. nodulosus* Luttrell and *C. homomorphus* Luttrell & Rogerson had previously been described as unitunicate by Luttrell (1957) and Luttrell and Rogerson (1959) respectively. *Cochliobolus* was again classified as a loculoascomycete by Luttrell (1973), but his illustration of an ascus from the teleomorph of *Bipolaris micropus* (Drechs.) Shoem. does not suggest a typical bitunicate structure. In contrast, Shoemaker (1955) reported that asci of *C. sativus* (Ito & Kurib.) Drechs. ex Dastur are bitunicate. This was visible in young asci with immature spores, where a canal filled with cytoplasm penetrated the endotunica at the apex, but was not visible in mature asci. Bitunicate asci have also been reported for *C. bicolor* Paul & Parbery (Paul & Parbery 1966), *C. miakei* Hino & Katumoto (Hino & Katumoto 1966), *C. palmivora* Rao & Chaudhury (Rao & Chaudhury 1964), and *C. sitharamii* Reddy (Reddy 1976). Other species of *Cochliobolus* have been recorded as having unitunicate asci. In addition to *C. homomorphus* and *C. nodulosus*, they include *C. carbonum* Nelson (Nelson 1959), *C. cynodontis* Nelson (Nelson 1964a), *C. geniculatus* Nelson (Nelson 1964c), *C. intermedius* Nelson (Nelson 1960b), *C. lunatus* Nelson & Haasis (Nelson & Haasis 1964), *C. spicifer* Nelson (Nelson 1964b), and *C. victoriae* Nelson (Nelson 1960a).

The primary character used in assigning fungi to the Loculoascomycetes is the bitunicate ascus (Luttrell 1955, 1973). Bitunicate asci have a double-layered wall, consisting of an ectoascus and an endoascus. The layers normally are separable, and function in ascospore discharge. The ectoascus is thin and inextensible, while the endoascus is thick and extensible. Just prior to spore release the ectoascus splits at the apex, and the endoascus expands apically, increasing the ascus length by two or three times. Spores are discharged through an apical pore in the endoascus. Although many loculoascomycetes follow this pattern of ascus dehiscence, variations have been recorded. In some species, a circumcissile split occurs in the ectoascus below the tip, allowing the apical section to be thrown off as a thimble-shaped cap. This phenomenon has been observed in *Sporormia, Leptosphaeria, Lecanidion,* and *Stomiopeltis* (Luttrell 1951).

Bitunicate asci of many species have an indentation at the apex of the endoascus, forming a short extension of the lumen filled with cytoplasm (Luttrell 1973). This was noted in *C. sativus* by Shoemaker (1955), but is not evident in other authors' illustrations or descriptions of various *Cochliobolus* species. Characters correlated with the presence of bitunicate asci are ascostromatic ascocarps and pseudoparaphyses, and Luttrell (1965, 1973) may have relied on these when assigning *Cochliobolus* to the Loculoascomycetes. Barr (1979) included *Cochliobolus* in the new family Pyrenophoraceae, together with *Pyrenophora, Setosphaeria,* and *Pseudocochliobolus*. She gave no data concerning ascus structure other than to state that asci of fungi in this family are bitunicate.

Drechsler (1925) reported that spore discharge in *Cochliobolus heterostrophus* (Drechs.) Drechs. was preceded by a 'swelling of the ascus and circumcissile rupture in the apical portion of the ascus wall'. In this species ascospores discharge simultaneously, with sufficient force for them to clear the ascus in water mounts (Drechsler 1925). Drechsler did not describe or illustrate a cap comprising the section of the ascus above the split, but his description of rupturing could indicate that a cap was formed. Shoemaker (1955) reported that asci of *C. sativus* mounted in water commonly dehisced by a circumcissile apical rupturing, but that they also occasionally broke open at the centre and base. He obtained no evidence of an endotunica functioning in spore discharge, nor was a residual endotunica detected in asci which had released spores. Luttrell (1957) found that in water mounts, asci of *C. nodulosus* split across the apex and the ascospores oozed out, uncoiling as they emerged. A similar description of spore release was given by Luttrell and Rogerson (1959) for *C. homomorphus*. Discharge of ascospores through a split in the ascus wall has also been reported for *C. carbonum* (Nelson 1959), *C. cynodontis* (Nelson 1964a), *C. geniculatus* (Nelson 1964c), *C. intermedius* (Nelson 1960b), *C. lunatus* (Nelson & Haasis 1964), *C. spicifer* (Nelson 1964b), *C. victoriae* (Nelson 1960a), and *C. sitharamii* (Reddy 1976). Dastur (1942) recorded that ascospores of *C. tritici* Dastur escaped through an opening formed at the ascus apex by dissolution of the wall.

Hall and Sivanesan (1972) coined the term 'vestigal bitunicate' to describe ascus structure in *C. cymbopogonis*. With regard to the ascus in this species, they wrote that it was 'typically bitunicate but on rupture no extension of the inner wall has been observed'. Dehiscence was not further described but apparently it occurred in the ascocarp, because one of their illustrations shows ascospores emerging from the ostiole in loosely coiled groups. Hall and Sivanesan examined the type collections of *C. nodulosus* and *C. homomorphus* and reported that these species also had vestigial bitunicate asci. El Shafie and Webster (1980) found that asci of *C. cymbopogonis* and *C. kusanoi* (Nisik.) Drechs. ex Dastur are partially bitunicate, with the endotunica represented by an apical cap which functions in ascospore liberation. My studies of this phenomenon included species not examined by El Shafie and Webster, and this additional information is presented here.

OBSERVATIONS

Asci from living material in cultures were examined. Mountants and stains used in examining ascus wall structure included water, lactofuchsin, ammoniacal erythrosin, Lugol's iodine, KOH-phloxine, ammoniacal Congo red, and aqueous azure A. For studies of ascospore discharge, ascocarps were crushed lightly in a drop of water to expel asci. In addition, some ascocarps were suspended individually in water on excavated slides.

The ascus in *Cochliobolus heterostrophus*

This species is the generic type (Drechsler 1934). In most preparations, the ascus apex did not exhibit a bitunicate structure. There was commonly a thin unstained wall 1-2 μm thick enclosing the deeply stained cytoplasm. Even when ascospores did not push completely into the apex, there was generally no evidence of an apical identation. Only two asci with a structure resembling an apical cytoplasmic channel were seen, one in KOH-phloxine and the other in azure A. The complex apical apparatus which occurs in unitunicate asci was not seen in this species.

The observations of Drechsler (1925) on ascospore discharge in *C. heterostrophus* could not be confirmed. In water preparations of crushed ascocarps, no discharge of spores from asci still attached basally to centrum tissue was detected. In asci lying free in the mount, spore discharge from the apex was not observed. Some ascospores escaped through the base of the ascus, the spores emerging singly through a narrow aperture at the base of the pedicel.

When unbroken ascocarps were immersed in water, ascospore discharge occurred after one hour at approximately 25°C. The released ascospores sometimes were coiled together, suggesting that each ascus released its contents as a unit under these conditions. Empty asci with a split at the apex were observed still attached to the base of the locule when these ascomata were crushed. In the same slides there were short, hyaline thimble-like structures measuring *ca.* 30 x 12 μm, with a rounded apex and a truncate base. After pressure was applied to the coverslip, a third type of structure was sometimes seen. It consisted of the apical portion of an ascus, freed by a circumcissile rupture of the wall. The released apical portion was double-walled. In some instances the inner wall of this structure became partly everted when the apical section of the ascus was forced off. The inner wall was still attached to the outer wall near the base of the detached structure (Fig. 2). Two small dark spots were visible at the apex of the inner wall.

The ascus in other *Cochliobolus* species

Stained preparations revealed no evidence of typical bitunicate ascus structure in *C. cymbopogonis*, *C. hawaiiensis* Alcorn, *C. kusanoi*, *C. ravenelii* Alcorn, and *C. tripogonis* Alcorn, but ascospore discharge in water mounts was seen for each species.

My observations on spore discharge in *C. cymbopogonis* agree with those of El Shafie and Webster (1980). Ascospore release begins within 20 seconds when ascocarps are crushed in water. The spores are released as a group, emerging rapidly through the apex of the ascus (Fig. 3). Each ascospore bundle has a hyaline, cylindrical, thimble-like structure over the apical portion. The term 'endoascal caps' is used below to refer to these structures.

The endoascal cap generally separates from each ascospore group as soon as spores are clear of the ascus. Straightening of the reflexed ascospore tips, and expansion of the ascospore sheaths and any matrix left in the cap, may be involved in this process. Occasionally the cap remains ensheathing the ascospore tips after discharge. Asci which have discharged spores commonly have an irregular apical split through which the spores were forced. In many, the split was more or less 'V' shaped and gave the ascus apex a bilabiate appearance. A broader, less regular rupture occurred in others, leaving a wide aperture. The torn wall sometimes was recurved at the margin of the opening. Occasionally the split occurred in a lateral position just below the rounded apex of the ascus, but this could be an artefact caused by pressure when applying the coverslip.

The endoascal caps carried out of the asci by the emerging spores are cylindrical, or slightly widened towards the base, hyaline, 75-100 x 15-20 µm with a smooth rounded apex and an irregular base which gives the appearance of having been torn away from a supporting structure. For comparison, intact mature asci of *C. cymbopogonis* measure 206-340 x 17.5-20 µm. Each cap has a wall up to 5 µm thick at the apex, becoming progressively thinner towards the base where it is almost indistinguishable. The lumen contains cytoplasm. At the apex of the cap there is sometimes a configuration similar to that seen at the apex of a typical bitunicate ascus, that is, a cytoplasm-filled pore projecting into the apical wall (Fig. 4). Preparations stained in lactofuchsin still had endoascal caps visible after three months, whereas the mucilaginous ascospore sheaths dissolved rapidly in this medium. The wall of each cap had narrowed to approximately half the thickness seen in water mounts, especially at the apex. Persistence of these structures in lactofuchsin strongly suggests that they are not mucilaginous in composition.

Asci undergo a reduction in length and width after spore release. Thirty-five asci which had discharged ascospores measured 185-258 µm (mean 220 µm). The same number of apparently mature asci still containing spores measured 206-330 µm long (mean 271 µm). Width of empty asci was 14-17.5 µm, and of mature asci 17.5-20 µm. Measurements of ascus length before and after spore discharge were obtained individually for five asci. The lengths were 299 µm (before) - 206 µm (after), 288-216 µm, 263-196 µm, 330-242 µm, and 319-237 µm.

Mature ascomata of *C. cymbopogonis* liberate ascospores in the absence of free water. In Petri dish cultures, long straw-coloured cirri up to 6 mm long and 80-150 µm thick were formed when spores exuded from the ostiole. These cirri contained ascospores, but no asci, lying parallel to the long axis of the cirrus. The spores were straight except at the tip, where many were curved to more or less uncinate. Recently formed cirri disintegrated rapidly when mounted in water, but this capacity was lost

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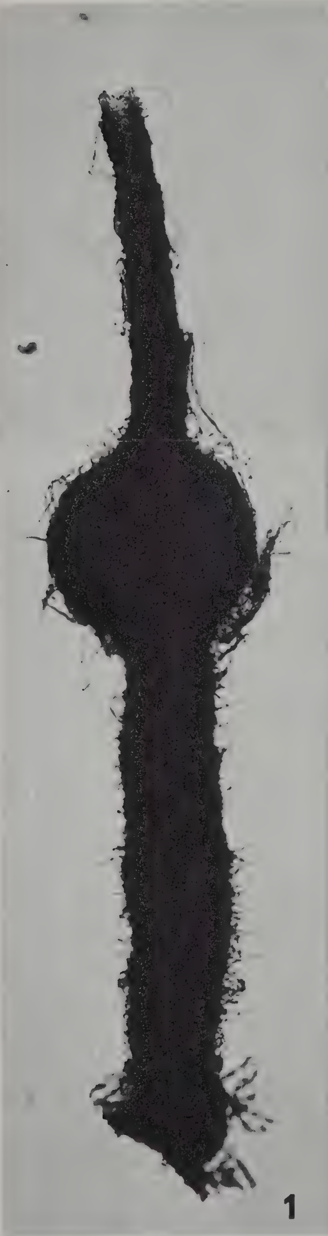
Fig. 1. Ascocarp of *Cochliobolus cymbopogonis*, from culture of IMI 130402 on Sach's agar + maize leaf (x60). Fig. 2. Broken ascus tip of *C. heterostrophus* showing partly everted endoascal wall and darkened tip of endoascus (x650). Fig. 3. Ascus of *C. cymbopogonis* with apical split through which the endoascal cap and ascospores are discharged (x650). Fig. 4. Endoascal cap of *C. cymbopogonis* (x800). Fig. 5. Ascospore bundle and endoascal cap of *C. tripogonis* (x400).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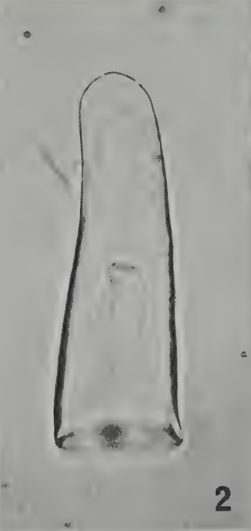
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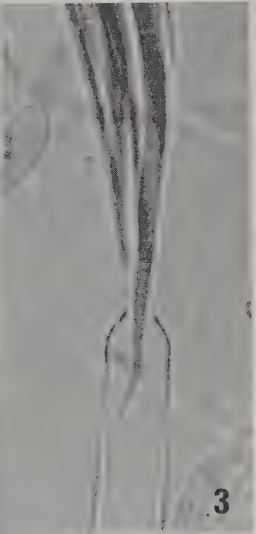
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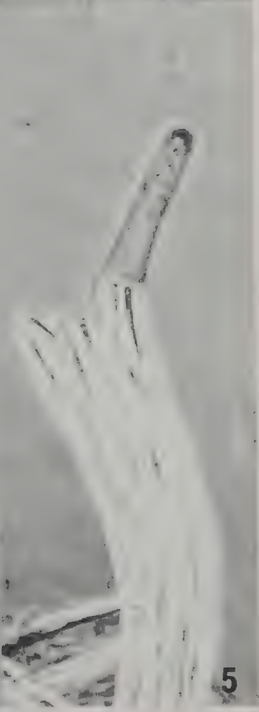
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in older, dried cirri. In addition to ascospores, the cirri contained numerous endoascal caps identical to those produced when asci dehisce in water. Ascocarps with long cirri still had asci containing ascospores in the globose ascogenous section. Empty asci with split apices were also present in the ascogenous locule of ascomata from which ascospores had been liberated. Spore release probably occurs in this part of the ascocarp, the ascospores being pushed up the long neck as other asci dehisce.

A discharge mechanism similar to that described above for *C. cymbopogonis* was also observed in *C. hawaiiensis*, *C. kusanoi*, *C. ravenelii*, and *C. tripogonis*. The endoascal caps in these species are similar in appearance to those of *C. cymbopogonis* (Fig. 5).

An hypothesis to explain ascus structure and function in *Cochliobolus* species

It is postulated that the ascus in *Cochliobolus* is bitunicate, and that the endoascus is thickened only in the upper portion. It is further suggested that the mechanical strength of the endoascus in the lower part is not great, and that this results in the wall of the endoascus rupturing in a circumcissile manner under the force exerted by escaping ascospores.

The presumed events up to and including spore discharge are as follows. As ascospores mature, the ascus is stretched to accommodate them. Eventually the ectoascus splits at the tip. The endoascus may expand as in a normal bitunicate ascus at this stage. It is considered more likely, however, that the endoascus is forced out of the ectoascus by the expanding ascospore bundle and ruptures at a point approximately one third of the ascus length from the apex. The endoascal cap is then carried away as a sheath over the tips of the ascospores. An alternative to this hypothesis would be that the lower portion of the endoascus is firmly bonded to the ectoascus, and cannot expand to accommodate the increase in pressure which precedes ascospore release. If present, the endoascus in this lower region is too thin to be distinguished by light microscopy. It might also be argued that the endoascus is not complete, being present only in the upper third of the ascus. This seems a less plausible explanation, because it would require the endoascus to be attached to the ectoascus in a narrow region in the upper part. If both walls were present in young, shorter asci, basauxic growth of the ectoascus would have to occur to bring about the condition of mature asci. Transmission electron microscopy possibly would help resolve these uncertainties concerning ascus structure.

Note on ascocarp morphology in *C. cymbopogonis*

The reports of Hall and Sivanesan (1972) and El Shafie and Webster (1980) indicate that ascomata of *C. cymbopogonis* are sessile, with a rounded ascogenous basal portion and a long cylindrical neck. When grown on Sach's agar + leaf of *Zea mays* L., the type culture of this species (IMI 130402) produces ascomata in abundance. Erect, cylindrical black stromata first develop on the leaf pieces, especially along the major veins. The ascomata differentiate singly at the apex of each stroma, so that at maturity each ascoma has a cylindrical sterile base (Fig. 1). These bases measure 500-1400(-1700) x 175-260 µm. On water agar + wheat straw, ascocarps are less numerous and most are sessile. Presence of a sterile stromatic base was one of the characters used by Tsuda, Ueyama, and Nishihara (1977) to distinguish the new genus *Pseudocochliobolus*. Clearly this facet of teleomorph morphology in *C. cymbopogonis* is conditioned by substrate. If this also applied in other species, it would be unsuitable for use as a generic criterion.

DISCUSSION

It is not clear whether the type species of *Cochliobolus* was studied by either Luttrell (1965, 1973) or Barr (1979), but both authors assigned this genus to the Loculoascomycetes. Barr stated that asci are bitunicate in the family Pyrenophoraceae, in which she included *Cochliobolus*. Luttrell (1965) believed that asci are unitunicate in *Cochliobolus*, while Hall and Sivanesan (1972) proposed the term 'vestigial bitunicate' to describe ascal structure in this genus. The data presented here and by El Shafie and Webster (1980) support the contention that *Cochliobolus* should be classified in the Loculoascomycetes, and offer some explanation for the differences of opinion concerning ascus structure in the genus. It is suggested that the term 'vestigial bitunicate' used by Hall and Sivanesan should be retained, because it seems that the endoascus plays no active role in spore discharge from the ascus. In this respect my interpretation of ascospore release in *Cochliobolus* differs from that of El Shafie and Webster (1980). They referred to a protrusion of the endoascus enclosing the spores, followed by spore release. I believe the endoascus plays a much more passive role, and that it is forced out of the ectoascus by the expanding ascospore mass. However the process occurs rapidly and individual steps cannot be distinguished.

Unitunicate asci may have an outer, denser layer which is not structurally different from the inner wall layer (Griffiths 1973). One of the interpretations of ascus structure in *C. cymbopogonis* and similar species raises the possibility of fusion of walls in the lower part of the ascus. If transmission electron microscopy shows this to be correct, then the ascus in *Cochliobolus* may represent an intermediate form between unitunicate and bitunicate types.

Five of the *Cochliobolus* species in which ascospore discharge was observed have narrow cylindrical asci. Fresh material of other species such as *C. sativus* and *C. victoriae*, in which asci are much broader, should be examined to ascertain whether the discharge mechanism is the same. It is also important that ascus structure in *Cochliobolus* be observed by transmission electron microscopy, to relate ultrastructural detail to form and function as interpreted after examination by light microscopy.

ACKNOWLEDGEMENT

I thank Dr. A.H.S. Onions for the type culture of *C. cymbopogonis*, and Mr. A.E. El Shafie for a culture of *C. kusanoi*.

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MYCOTAXON

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A PRELIMINARY DISCOMYCETE FLORA OF MACARONESIA: PART 6, GEOGLOSSACEAE*

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> "Was never eare, did heare that tong."
> Edmund Spenser
> AN ELEGIE, OR FRIENDS PASSION, FOR HIS ASTROPHILL, Line 110

Order HELOTIALES
Suborder HYMENOSCYPHINEAE
Family GEOGLOSSACEAE Corda 1838

KEY TO THE KNOWN MACARONESIAN GENERA

1. Ascospores brown at maturity 2
1'. Ascospores hyaline at maturity 4

2(1). Hymenial setae present. **Trichoglossum**
2'(1). Hymenial setae absent 3

3(2'). Paraphyses restricted to hymenium, not running down stipe; stipe dry. **Geoglossum**
3'(2'). Paraphyses running down the stipe; stipe glutinous. **Gloeoglossum**

4(1'). Ascoclavula black or blackish. **Thuemenidium**
4'(1'). Ascoclavula paler, not blackish. **Microglossum**

GEOGLOSSUM Gillet 1879

One known Macaronesian species

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* The parts of this flora will appear in irregular order. Reprints of individual parts will not be available for distribution.

1. **Geoglossum umbratile** Saccardo, Michelia **1:** 444. 1878, var. **umbratile**

MISAPPLIED NAME: *Geoglossum nigritum* (Pers. : Fr.) Cke.

RECENT TAXONOMIC TREATMENTS: Benkert (1976), Maas Geesteranus (1965), Mains (1954), Nannfeldt (1942).

PREVIOUS MACARONESIAN RECORDS: None.

TYPE LOCALITY: Italy.

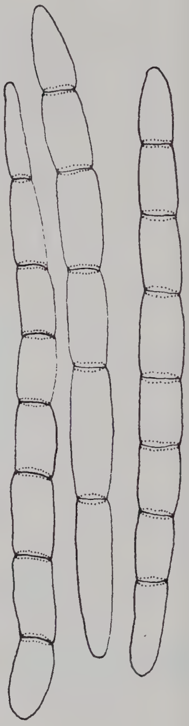
KNOWN MACARONESIAN DISTRIBUTION

CANARY ISLANDS.

Tenerife. CUP-MM 21 (OSC, TFC, to be issued in Korf & Gruff, Disc. Exs.), 1272 (TFC), 1279 (TFC), 1308 (TFC).

SUBSTRATA: On soil in ditches and on roadside banks.

Notes: Mains (1954) and Nannfeldt (1942) use the name *G. nigritum*, and our Macaronesian collections were initially identified as *G. nigritum* var. *nigritum*, but Maas Geesteranus (1965) has shown that name applies correctly to a basidiomycete (Persoon originally described it as *Clavaria nigrita*, and it has been consistently misinterpreted since then).



G. umbratile v. umbratile, 3 ascospores, CUP-MM 1272, x 1000.

GLOEOGLOSSUM Durand 1908

One known Macaronesian species

1. **Gloeoglossum glutinosum** (Pers. : Fr.) Durand, Ann. Mycol. **6:** 419. 1908.

≡ *Geoglossum glutinosum* Pers., Obs. Myc. **1:** 11. 1796, : Fries, Syst. Myc. **1:** 489. 1821.

RECENT TAXONOMIC TREATMENTS: Mains (1954), Nannfeldt (1942).

PREVIOUS MACARONESIAN RECORDS: None.

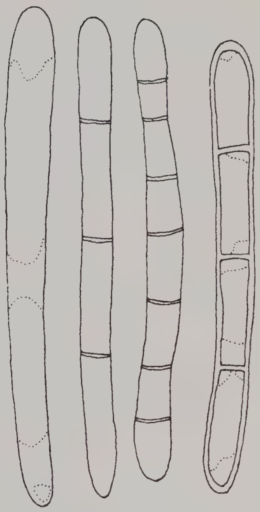
TYPE LOCALITY: Europe.

KNOWN MACARONESIAN DISTRIBUTION

MADEIRA.
Madeira. CUP-MM 1566.
CANARY ISLANDS.
Gomera. CUP-MM 1168(O).
Tenerife. CUP-MM 1187(TFC).

SUBSTRATA: On soil.

Notes: Though most modern authors do not accept Durand's segregate genus, the glutinous stipe makes it an easy taxon to recognize even in the field.



Gl. glutinosum, 1 immature ascospore, 3 mature, CUP-MM 1566, x 1000.

MICROGLOSSUM Gillet 1879

One known Maraconesian species

1. **Microglossum olivaceum** (Pers. : Fr.) Gillet, Champ. France discomyc., livr. 1, p. 26. 1879.

RECENT TAXONOMIC TREATMENTS: Dennis (1978), Mains (1956), Nannfeldt (1942).

PREVIOUS MACARONESIAN RECORDS: None.

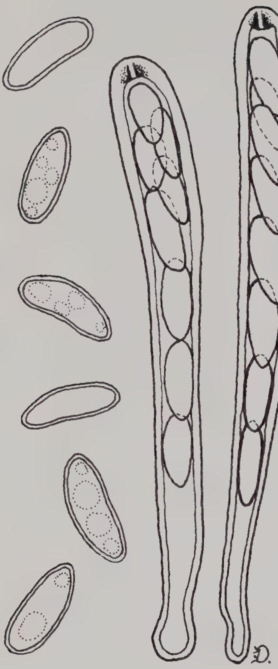
TYPE LOCALITY: Europe.

KNOWN MACARONESIAN DISTRIBUTION

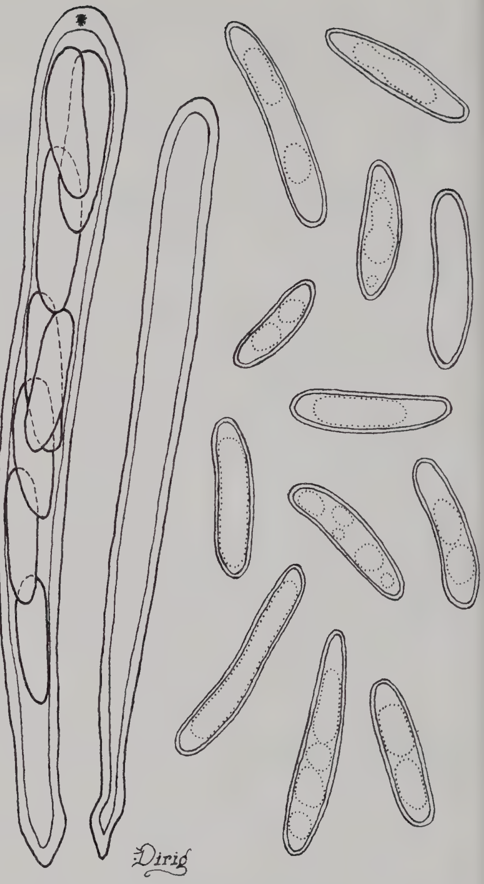
CANARY ISLANDS.
Tenerife. CUP-MM 1307(TFC).

SUBSTRATA: On soil.

Notes: Mains (1956) included Thuemenidium (= Corynetes) in his very broad concept of the genus.



M. olivaceum, 6 ascospores, 2 asci with J+ pore wall channel, 6 ascospores, CUP-MM 1307, x 1000.



Th. atropurpureum, mature ascus with J+ pore wall channel, immature ascus, 12 ascospores, CUP-MM 1371, x 1000.

THUEMENIDIUM Kuntze 1891 emend. Maas Geesteranus 1964

One known Macaronesian species

1. **Thuemenidium atropurpureum** (Batsch : Fr.) Kuntze, Revis. gen. pl. **2:** 875. 1891.

≡ *Corynetes atropurpureus* (Batsch : Fr.) Durand, Ann. Mycol. **6:** 414. 1908.
≡ *Microglossum atropurpureum* (Batsch : Fr.) Karst., Acta Soc. Fauna Fl. Fenn. **2(6):** 110. 1885.

RECENT TAXONOMIC TREATMENTS: Dennis (1978), Maas Geesteranus (1964), Mains (1956: Microglossum), Nannfeldt (1942: Corynetes).

PREVIOUS MACARONESIAN RECORDS: *Bañares Baudet & al. (1980), † Beltrán Tejera (1980), **Cool (1924), ***Cool (1925).

TYPE LOCALITY: Europe.

KNOWN MACARONESIAN DISTRIBUTION

* ** ***CANARY ISLANDS.

***Gomera.** *CUP-MM 1371(TFC[=TFC 770]).

**** ***Tenerife.** CUP-MM 1136(O), ** ***1652(L).

SUBSTRATA: On soil.

Notes: Though the criterion of an amorphous, colored pseudoepithecium has been used to distinguish Thuemenidium, it is often absent. Mains (1956) I think correctly synonymized 3 species Durand (1908) distinguished in his monograph, Corynetes atropurpureus, C. purpurascens, and C. robustus, the last with an epithecium "lacking or inconspicuous," and with more robust ascoclavula, and somewhat longer spores. The collection from Gomera, reported by Bañares Baudet & al., was taken during one of our expeditions to Gomera, together with the staff of the Universidade de La Laguna. It has no trace of a colored pseudoepithecium, and thus matches C. robustus, and also has very large ascoclavula, but the ascospores are within the typical range of T. atropurpureum. A better criterion, perhaps, is the peculiar dual-hyphal structure in the stipe, evident in the Gomera collection as well, which was stressed by Maas Geesteranus (1964). Mains (1956) included this in Microglossum, while Maas Geesteranus points out that it may belong in Geoglossum, differing mainly only in the colorless (and non-septate) ascospores. Corynetes arenarius (Rostrup) Durand, from Greenland, is also a Thuemenidium, but C. globosus (Sommerf. : Fr.) Durand from Scandinavia, the Alps, Greenland, and probably Canada is a Sarcoleotia according to my studies, though treated in Corynetes by Nannfeldt (1942); Maas Geesteranus (1964) showed it could not be a Thuemenidium.

TRICHOGLOSSUM Boudier 1885

One known Macaronesian species

1. **Trichoglossum hirsutum** (Pers. : Fr.) Boud., Hist. classific. discomyc. Europe, p. 86. 1907, var. **hirsutum**

RECENT TAXONOMIC TREATMENTS: Dennis (1978), Mains (1954), Nannfeldt (1932).

PREVIOUS MACARONESIAN RECORDS: *Baagøe & al. (1972), ** Beltrán & Wildpret (1975), † Beltrán Tejera (1980).

TYPE LOCALITY: Europe.

KNOWN MACARONESIAN DISTRIBUTION

*MADEIRA.

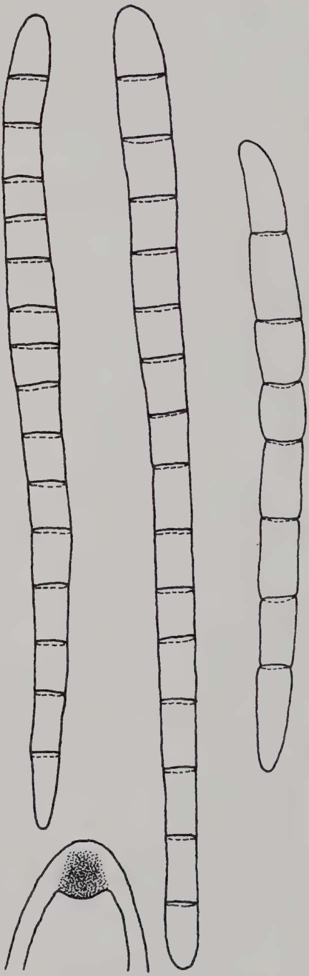
***Madeira.** CUP-MM 1492(TFC, OSC), 1495, 1538, 1574 (TFC), 1597, 2339, *2499 (C: as "sp."), *2501(C).

**CANARY ISLANDS.

La Palma. CUP-MM 668, 669 (TFC, OSC).

****Tenerife.** CUP-MM 1113(O), 1114(O), 1127(O), 1167 (O), 1261(TFC), 1296, 1298(TFC, OSC, to be issued in Disc. Exs.), **2507(TFC), **2509(TFC).

SUBSTRATA: On bare soil and among mosses.



Tr. hirsutum var. **hirsutum**, 2 15-septate ascospores, ascus apex in iodine, CUP-MM 1113; 7-septate ascospore, CUP-MM 2507; all x 1000.

MYCOTAXON

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The Psilopezioid fungi. VII.
A new species of *Psilopezia* from France.

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Psilopezia nummularialis Pfister and F. Candoussau sp. nov.* Receptacles gregarious, 1-3 cm diam, sessile, convex, later convoluted, broadly attached to the substrate, surrounded by a white mycelium which is particularly evident in dried material. External surface lighter. Hymenium gazelle colored, a rich ochraceous, the pigment soluble. The flesh paler than the hymenium 1 to 2 mm thick toward the center, translucent, brownish when dried.

Outer excipulum of two indistinct layers; inner layer of ± parallel, septate hyphae which become loosely intertwined, 9-10 µm in diam on the inner position and 20-35 µm toward the outer one or two cells of this inner layer. The outer layer, non-gelatinous, of interwoven hyphae about 12-15 µm in diam with a few free hyphal tips which sparsely cover the outer surface.

Medullary excipulum of textura intricata of cells 10-15 um in diam.

Asci 8-spored, 400 x 18-22 µm broad with evident croziers.

Paraphyses encrusted with brown amorphous material, branching and septate below 9-11 µm.

HOLOTYPE: sur tronc de *Salix* pourri, a terre, endroit inonde periodioquement, avec *Pachyella* sp. et *Climacodon pulcherrimus* (Berk. & Curt.) Nikol. Forêt de Bugangue (Oloron) Pyrénées Atlantiques. F. Candoussau. 14.IX.1980. Holotype FH, Isotypes F.C. no. 3757 and CUP 59826.

Other collections made in October and November in the same locality are in FH and the collection of the junior author.

This species is close to *Psilopezia nummularia* Berk.

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*Psilopezia nummularialis *Pfister & F. Candoussau sp. nov.*
Similis Psilopezia nummularia *Berk. sed ascosporis 26-29 x 12-15 µm, ascis 400 x 18-22 µm et hymeniis ochraceis.*
Holotypus: sur tronc de Salix *pourri, a terre, endroit inonde peridioquement, avec* Pachyella *sp. et* Climacodon pulcherrimum *(Berk. & Curt.) Nikol. Forêt de Bugangue (Oloron) Pyrénées Atlantiques. F. Candoussau. 17.IX.1980. Holotype FH; Isotypes F.C. no. 37571 and CUP 59826.*

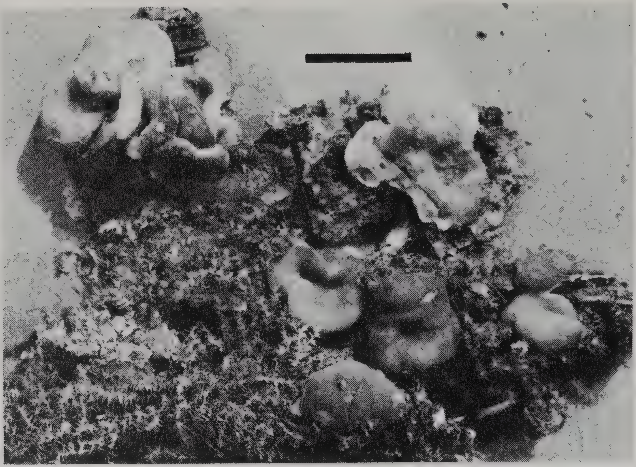

Figure 1. Apothecia of *Psilopezia nummularialis* scale = 2 cm.

which has been collected in Europe and is known in some of the literature under the name Peziza atroviolacea Bres., shown to be a later synonym (Pfister 1973). The two species can be distinguished as follows:

	P. nummularialis	P. nummularia
Hymenial color	ochraceous	olivaceous, or nearly black
Asci	400 x 18-22 µm	275-300 x 20-27 µm
Ascospores	26-29 x 12-15 µm	29-40 x 14-20 µm
Outer zone of outer excipulum	10-17 µm	up to 35 µm

In anatomical features Psilopezia nummularialis and P. nummularia are quite similar. It should be pointed out that a report by Beller (1972) of Psilopezia nummularia is in fact Pachyella babingtonii Berk. & Br.

The work of the senior author was supported in part by National Science Foundation Grant DEB 8023018. We thank E. Jarias for photographs.

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MYCOTAXON

Vol. XIII, No. 2, pp. 369-372 July-September 1981

NOTES ON SOIL FUNGI ISOLATED FROM A 15-YEAR-OLD ASPEN STAND IN INTERIOR ALASKA

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SITE DESCRIPTION

The sampling site, a quaking aspen (*Populus tremuloides* Michx.) stand located 42 kilometers northeast of Fairbanks, Alaska, is an area between 150 and 210 meters above sea level and is situated at 146°50'W longitude and 64°54'N latitude. Soil is alluvial silt-loam of the Goldstream-Saulich series. The lowland site has a slope of between 3 and 7%. Mean annual precipitation and temperature for the Fairbanks vicinity are 28.7 cm and -3.4°C, respectively. A severe forest fire 15 years prior to sample collection destroyed virtually all surface vegetation on the study area. Nearly all trees and other plants now present in the area are less than 15 years of age. Present cover is suspected to have originated from surviving root stock and sprouts. Average tree height in the burn area is approximately five meters; diameters are eight centimeters or less, and ground vegetation is very sparse.

METHODS AND MATERIALS

Prior to sampling for soil fungi, factorial applications of N, P and K fertilizers were made to the sample plots as part of an on-going experiment dealing with organic matter production. The present study was limited to sampling from the nitrogen, phosphorus, potassium application and control plots of that experiment. Plots were fertilized in the fall prior to sampling and again in May of the same year at the rates of 112 kg/ha NH_4NO_3 for the nitrogen plots, 56 kg/ha P_2O_5 for the phosphorus plots and 112 kg/ha KCl for the potassium plots. Sampling began in late May and continued once a week for eight weeks. A 6.5 cm corer was used to collect three cores of surface material from each of two subplots in each of the three replicate fertilizer and control plots (eighteen cores for each treatment). Cores for each treatment were combined for fungal isolation. The litter layer of the site was present in too small a mass to be used alone for sample analysis. The fermentation and humus layers were indistinguishable; hence the entire organic layer of the cores was used. The depth of this total organic layer was never more than 3 cm but never less than 2 cm. Organic content of the layer was calculated by sample ignition in a muffle furnace at 700°C for four hours. It ranged from 41.4 to 81.7%. Soil pH ranged from 4.7 to 7.5 and was determined on a saturation paste using a glass

TABLE: FUNGI

SPECIES	ALL AGARS Treatment					PDA Treatment					PDARB Treatment					PDARBS Treatment					SE Treatment				
	N	P	K	C	total	N	P	K	C	total	N	P	K	C	total	N	P	K	C	total	N	P	K	C	total
**Penicillium soppi* Zaleski	50	54	60	109	273	20	16	20	34	90	10	15	17	27	69	12	14	16	24	66	8	9	7	24	48
**Penicillium pinetorum* Christensen and Backus	11	31	23	17	82	1	5	8	4	18	2	6	5	5	18	6	10	8	3	27	2	10	2	5	19
**Penicillium thomii* Maire	28	24	14	10	76	11	15	5	1	32	8	4	4	4	20	1	3	4		8	3	1	2	4	10
*Unknown #1	25	18	7	3	53	2	2	1	1	6	5	4	1	2	12	7	6	3		16	11	6	2		19
**Penicillium* sp. #1	7	18	18	9	52		3	1	2	6	3	5	11	1	20	2	4	2	1	9	2	6	4	5	17
**Mortierella vinacea* Dixon-Stewart	3	14	14	4	35		2	5		7		2			2	1		4	2	7	2	10	5	2	19
**Penicillium* sp. #2	1	3	22	1	27			1		1	1			1	2		2	1		3		1	20		21
Mucor varians Povah	14	2	6	1	23	4	1	1		6	1				1	1	1	3		5	8		2	1	11
Mycelia Sterilia sp. #1	8	6	4	1	19						2	2	3		7	6	4	1	1	12					
Fusareum roseum Link	14			1	15	4				4	3				3	3				3	4			1	5
Trichoderma viride Link ex Fries	3	1	5	6	15			3	6	8	2				2	1	1	2	1	5					
Mycelia Sterilia sp. #2	5	6	2	1	14		2			2	1	2	1		4	4	2	1	1	8					
Mycelia Sterilia sp. #3	2	6	3	1	12	1	1	2		4			1		1						1	5		1	7
*Unknown #2	5		4	3	12			1		1	1				1	2		2	3	7	2		1		3
Mortierella gracilis Linnemann	4	2	3	3	12						1	1	1		3			2	3	5	3	1			4
**Mortierella isabellina* (Oudemans) Zycha	1	2	1	4	8	1				1		2	1	4	7										
Sphaeronaema spinella Kalchbrenner	2		2	5	9	1			1	2			1	1	2	1			3	4			1		1
Steptomyces sp.	4	1		2	7																4	1	2		7
**Mortierella nana* Linnemann	4		2		6	3		1		4											1		1		2
Penicillium chrysogenum Thom		1	2	2	5							1	2		3				2	2					
Actinomyces sp.			3	1	4																		3	1	4
Penicillium frequetans Westling			1	3	4				1	1									2	2			1		1
Penicillium restrictum Gilman and Abbott		4			4		1			1		3			3										
Penicillium funiculosum Thom		2		1	3												2		2					1	1
Penicillium solitum Westling	1		1	1	3						1		1	1	3										
Mycelia Sterilia sp. #4	2			1	3						2			1	3										
Stachybotris atra Corda	1	1	1		3						1	1	1		3										
**Mortierella alpina* Peyroud	1			1	2											1			1	2					
Mucor fragilis Bainier			2		2													2		2					

ISOLATED

Penicillium coryophilum Dierckx	1	1			2		1			1	1				1										
Mycelia Sterilia sp. #5	1	1			2											1	1			2					
*Unknown #3		2			2		1			1							1			1					
**Penicillium* sp. #3				2	2														2	2					
Fusarium semitectum Berkeley and Ravenel	1				1	1				1															
Monosporium minutissimum Rivolta				1	1									1	1										
Zygorhynchus heterogamus Vuillemin			1		1			1		1															
Penicillium aspernum (Shear) Raper and Thom	1				1	1				1															
Penicillium kapuscinskii Zaleski				1	1				1	1															
Mycelia Sterilia sp. #6	1				1						1				1										
**Chrysosporium pannorum* (Link) Hughes	1				1											1				1					
**Cytospora* sp. #1				1	1														1	1					
**Cytospora* sp. #2				1	1																			1	1
**Coniothyrium* sp.				1	1																			1	1

N = Nitrogen (NH_4NO_3)	PDA	= Potato dextrose agar
P = Phosphorus (P_2O_5)	PDARB	= Potato dextrose agar with rose benqal
K = Potassium (KCl)	PDARBS	= Potato dextrose agar with rose bengal and streptomycin
C = Control	SE	= Aspen soil extract agar

*Identified or confirmed by the staff of the Centraalbureau voor Schimmelcultures, Netherlands.

electrode pH meter. Above ground temperature for the study period ranged from -4°C to 28°C. Soil moisture content over the period of the study ranged from 12.4 to 176.6% (wet weight %).

Samples were plated in replicates onto four different agar media. A different agar was used each week. The agars used were: potato dextrose agar at pH 4.0 (PDA); potato dextrose agar with rose bengal added (PDARB); potato dextrose agar with rose bengal and streptomycin added (PDARBS); and aspen soil extract agar (SE). The dilutions from which the fungi were taken were 10^{-5} for all potato dextrose agars and 10^{-4} for the soil extract agar. Five colonies from each of five plates prepared for each area were isolated and cultured on potato dextrose agar pending fungal identification.

RESULTS

Species were identified using methods outlined by Raper and Thom (1946), Barnett (1960) and Gilman (1971). In all, 800 fungi were isolated. Duplicate species were discarded and by the end of the study 43 species had been isolated. Twenty of the more difficult species to identify were sent to Dr. J.A. Von Arx at the Centraalbureau voor Schimmelcultures in the Netherlands for identification. Those that his staff confirmed or identified are indicated by an asterisk in the accompanying table of fungi. Fungi not identified were given a number notation. Four of the Mycelia Sterilia species had noticeable clamp connections, indicating the presence of basidiomycetes.

ACKNOWLEDGEMENTS

We would like to thank Terrence A. Moore and Dr. Gary A. Laursen for their advice and criticism of this paper. The research was funded in part by the McIntire Stennis Cooperative Forest Research Program.

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MYCOTAXON

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COPRINUS SECT. HERBICOLAE FROM CANADA, NOTES ON EXTRALIMITAL TAXA, AND THE TAXONOMIC POSITION OF A LOW TEMPERATURE BASIDIOMYCETE FORAGE CROP PATHOGEN FROM WESTERN CANADA

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ABSTRACT

The pathogenic low temperature basidiomycete (LTB) affecting turf grass, forage legumes and winter cereals in western Canada is described as *C. psychromorbidus* sp. nov. A second western species is described as *C. maysoidisporus* sp. nov. *Coprinus* section *Herbicolae* is revised and a key to the accepted species given. The study of type specimens led to the conclusions that *Coprinus saichiae* Reid and *C. rhombisporus* Orton are synonyms of *C. friesii* Quél. *Coprinus brassicae* Peck, *C. melo* Favre and *C. suburticicola* Pil. & Svr. are synonyms of *C. urticicola* (Berk. & Br.) Buller. *Coprinus pseudofriesii* Pil. & Svr. and *C. xantholepis* Orton are synonyms of *C. phaeosporus* Karst., and *Coprinus amphibius* Anast. is a synonym of *C. kubickae* Pil. & Svr.

In addition, *Coprinus paleotropicus* sp. nov., *C. neotropicus* sp. nov. and *C. austrofriesii* sp. nov. are described for tropical collections previously reported as *C. urticicola*, *C. brassicae* and *C. friesii*.

A previously unidentifiable low-temperature basidiomycete (LTB) known to cause snow mold damage to turf grasses, winter cereals, forage legumes and native perennials (Broadfoot 1936, Broadfoot & Cormak 1941, Lebeau 1969) has been identified as a species of

Coprinus in the section *Herbicolae* (Traquair 1980). The specific identity of this *Coprinus* could not be ascertained from existing publications. Furthermore, although a re-evaluation of type materials for names published for species here considered in section *Herbicolae* revealed some inconsistencies, none of these species were conspecific with the pathogenic *Coprinus*. The fungus and a second species isolated with it are described as new. Descriptions of other species known to occur in Canada, a discussion on related taxa and a key to species accepted in section *Herbicolae* are also given. A description of the cultural characteristics of one species follows the taxonomic portion. Three tropical species are described as new and problematic species are discussed.

A key to *Coprinus* section *Herbicolae*

A. Spores blackish to blackish brown and rapidly losing their colour and form in concentrated sulfuric acid solution or doing so within 1-5 minutes .... B

A. Spores pale to dark brown or blackish brown, remaining relatively dark and intact in concentrated sulfuric acid solution for over 5 minutes .... D

  B. Veil elements with hyaline thin walls; spores blackish brown, ovoid .... *C. kubickae*

  B. Veil elements with hyaline moderately thin walls lightly incrusted with brown pigments; spores blackish, shaped like maize kernels C

C. Spores 5.5-6.5 X 5.0-5.2 X 4.5-4.8µm; European .... *C. argenteus*

C. Spores 7-9 X 6-7.6 X 5.1-5.3µm; North American .... *C. maysoidisporus*

  D. Spores globose to subglobose, 4.5-5.0 X 4.5-4.8µm, apically rugulose .... *C. herinkii*

  D. Spores not globose, larger, smooth .... E

E. Veil elements hyaline or subhyaline, in one species tending to become faintly yellowish with age or on drying .... F

E. Veil elements prominently pigmented, brownish to golden brown I

  F. Veil elements thick-walled, over 0.5µm thick in places .... G

F. Veil elements thin-walled, under
0.5μm thick .... H

G. Spores 9.6-11.8 X 7.2-8 X 7-9μm;
S. American .... *C. austrofriesii*

G. Spores 7.5-9.3 X 5.5-7.9μm;
N. Hemisphere .... *C. friesii*

G. Spores 3.8-4.2 X 4.5-5.3μm;
N. American .... *C. burkii*

H. Spores predominantly ovate in face
view, slightly compressed in profile,
6.1-8 X 4.5-5 X 5.8-6.7μm, walls
thickening; African .... *C. paleotropicus*

H. Spores predominantly broadly ellipsoid
to near subglobose, 5.5-8 X 3.9-5.1μm,
walls relatively thin; N. Hemisphere .... *C. urticicola*

H. Spores ellipsoid to ovoid,
8-9.5 X 6.5-7.5μm, walls relatively
thin; S. American .... *C. neotropicus*

I. Veil element walls refractive, thickened,
often 0.5-1.0μm thick over long segments;
elements much branched, with some units like
matured deer antlers; golden in colour .... J

I. Veil element walls thin to only slightly
thickened; elements moderately branched, at
most some units shaped like young blunt deer
antlers; brownish in colour L

J. Spores obscurely to prominently angular
in face view, being an elongated hexagon .... *C. herbivorus*

J. Spores ovate to elliptical in face view .... K

K. Spores 5-7(-8) X 5-6μm, in face view, broadly
ovate, less so in profile; with a nearly lateral
eccentric apiculus on many; European .... *C. phaeosporus*

K. Spores (6.4-)7.2-8.8(-9.6) X (4.2-)5-6(-7.3)μm,
in face view, typically ovate to broadly elliptical,
varying in different isolates, some with nearly all
spores broadly ovate, in others with nearly all
elliptical; apiculus slightly eccentric to nearly
lateral; North American .... *C. psychromorbidus*

K. Spores 9.5-11.5 X 6.5-7.0µm, in face view
ovate to elliptical; apiculus slightly
eccentric; Jamaican (on wood) .... *C. cinchonensis*
  L. Spores 5.7-7 X 4.5-6µm;
  South American .... *C. subtigrinellus*
  L. Spores 8-10 X 6.8-7.1µm; European .... *C. tigrinellus*

SPECIES FOUND IN CANADA

**Coprinus friesii* Quélet (1872: 159, tab. 23, no. 5) Figs. 13,14,16, 29,34,44-47.

≡ *Coprinopsis friesii* (Quél.) Karsten (1881: 27)
= *Coprinus saichiae* Reid (1958: 430)
= *Coprinus rhombisporus* Orton (1972: 145)

PILEUS 3-5 mm high unexpanded, narrowly paraboloid-conical, white to whitish, sometimes tinted faintly brownish towards the center, finely appressed floccose scaly towards the disc, becoming pale mouse grey and vaguely striate when fertile, expanding to plane, with edges becoming revolute. LAMELLAE ascending, nearly free, white, becoming greyish-sepia, crowded, somewhat deliquescing with age. STIPE 5-20 X 0.2-0.5 mm, subequal, white, nearly glabrous to minutely pulverulent, with a flattened basal disc fringed with tapering radiating mycelial strands.

PILEAR VEIL ELEMENTS: loosely interwoven, 2-4.5µm diam., somewhat duplex, lower elements with a poorly developed coralloid branching pattern, thin-walled, sometimes obscurely roughened, hyaline or faintly brownish, tending to deliquesce early, upper or outer elements normally well developed but sometimes nearly lacking, with a well developed thorny to antler-like branching pattern, thick-walled, having numerous elongated narrow branchlets which are solid or nearly so, smooth to vaguely roughened; veil elements loosely attached to the trama tissue which lacks a well developed pellis. PILEUS TRAMA: hyphae radiating, 3-5µm diam., little inflated, thin-walled, hyaline, smooth, with simple and clamped septa. LAMELLAR TRAMA: exceedingly thin; 2-3 hyphae thick, loosely interwoven, and often septate, nearly forming a pseudoparenchymatous layer, hyaline, thin-walled. PLEUROCYSTIDIA: scattered, numerous, 70-75 X 14-20µm, subcylindrical to fusoid, thin-walled, hyaline. CHEILOCYSTIDIA: polymorphic, a mixture of shorter pleurocystidia-like elements, swollen brachybasidium-like elements and thin-walled veil-like elements forming a mat over the lamellae edges. BASIDIA: dimorphic,

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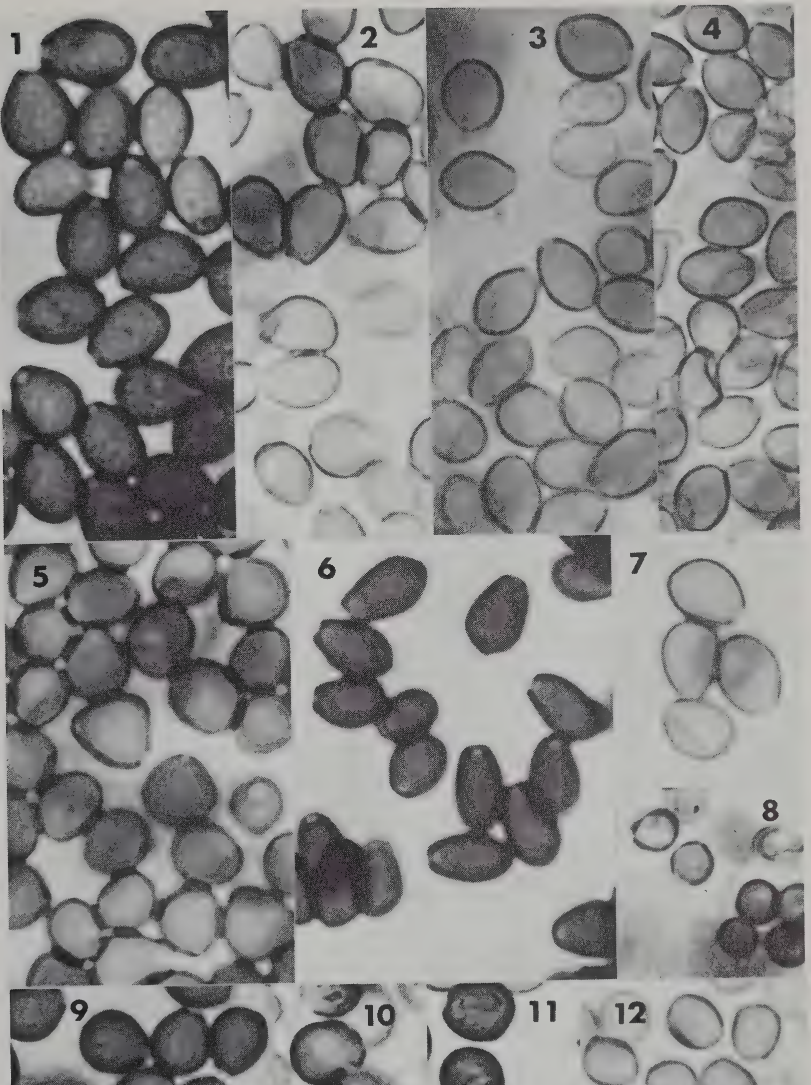
Figs. 1-12. Basidiospores. 1, *C. psychromorbidus* DAOM 175229. 2, *C. psychromorbidus* DAOM 179229. 3, *C. psychromorbidus* DAOM 175232. 4, *C. psychromorbidus* ex Dearness DAOM. 5, *C. psychromorbidus* DAOM 189345. 6, *C. psychromorbidus* DAOM 177600. 7, *C. psychromorbidus* DAOM 175226. 8, *C. herinkii* Type at PRM. 9, *C. pseudofriesii* Type at PRM. 10, 11, *C. xantholepis* Type at E. 12, *C. phaeosporus* Type at H. All ca. 1,200 X mag.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15-21 X 8.8-9.7µm, 4-spored, subglobose with a short to long tapering pedicel, spaced by swollen brachybasidia forming a rosette pattern. BASIDIOSPORES: 7.5-9.3 X 5.5-7.9µm, usually broadly ovate in face view, varying to broadly elliptical, inequilateral in profile with a less convex surface on the abaxial surface, thick-walled, smooth, brown vinaceous in mass, sienna in H_2O, with a well developed apical germ pore. STIPE HYPHAE: parallel, often inflated especially internally, 3-15µm diam., hyaline, thin-walled, smooth.

HABITAT and SUBSTRATES: On leaf litter of *Typha* and *Carex* (Ont.) or unspecified monocots (Que.) in wet fields or temporary pools.

COLLECTIONS EXAMINED: CANADA: *Ontario:* Ottawa, June 28, 1979, S.A.R. 3455 (DAOM 175138). *Québec:* Cantley, July 15, 1980, J. Ginns (DAOM 177601). ENGLAND: Hertfordshire, King's Langley, Sept. 23, 1955, R.A. Saich (K, type for *C. saichiae*); Norfolk, Surlingham, Wheatfen Broad, Aug. 3, 1968, P.D. Orton 3249 (E, type for *C. rhombisporus*). SWEDEN: Västergötland, Göteborg, St. Änggården, Aug. 2 & 3, 1937, T. Nathorst-Windahl 658 (DAOM, Lundell & Nannfeldt 2928 as *C. friesii*).

An authentic Quélet collection of *Coprinus friesii* could not be located at Paris (PC). The concept adopted here is that of Pilát & Svrček (1967), Lundell & Nannfeldt (1979), Kühner & Romagnesi (1953) and Romagnesi (1937), i.e. a species with thick-walled, hyaline to faintly yellowish, coralloid veil elements and broadly ovoid brownish spores 7.5-9.3 X 5.5-7.9µm.

The types for both *Coprinus saichiae* (figs. 16, 47) and *C. rhombisporus* (figs. 13, 45) do not differ significantly from other collections of *C. friesii*. There is a slight variation in the colour of the veil elements, from hyaline to faintly yellowish, and in spore sizes but these are not unexpected considering the variations found in the better documented case of *C. psychromorbidus*. Nearly complete sterility or a nearly complete arrestment of full veil development as in DAOM 175138, make identifications difficult.

In Europe, *Coprinus friesii* has been found on senescent *Trifolium, Lupinus, Chenopodium, Arctium, Robinia, Carex* and various grasses (see references above, Orton & Watling 1979, and Lange 1915, 1939). It has also been reported from Morocco (Malençon & Bertault 1970) on *Phragmites* and *Juncus*, and from Japan (Imazeki & Hongo 1965). The report from Venezuela by Dennis (1961) is based on *C. austrofriesii* (q.v.).

**Coprinus kubickae* Pilát & Svrček (1967, Aug.: 142) Figs. 67,68
= *Coprinus amphibius* Anastasiou (1967, Nov.: 2213-4).

COLLECTION EXAMINED: CANADA: *British Columbia*: basidiocarps from a

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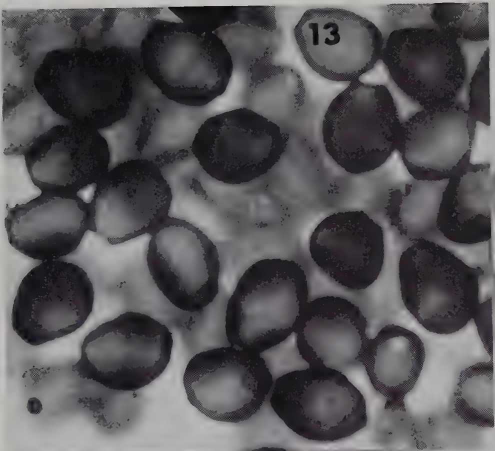
Figs. 13-20. Basidiospores. 13, *C. rhombisporus* Type E. 14, *C. friesii* ex Lundell & Nannfeldt DAOM. 15, *C. herbivorus* Type at F. 16, *C. saichiae* Type at K. 17, *C. suburticicola* Type at PRM. 18, *C. urticicola* DAOM 175421. 19, *C. brassicae* Type at NYS. 20, *C. melo* Type at G. All ca. 1,200 X mag.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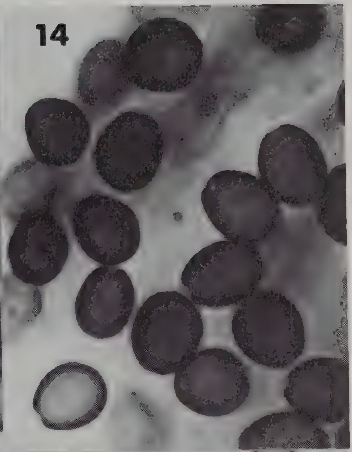
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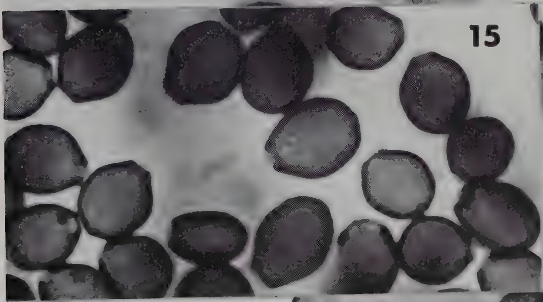
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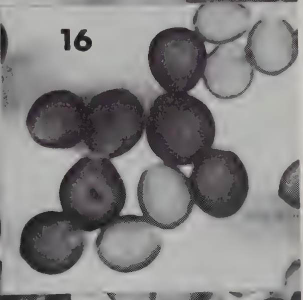
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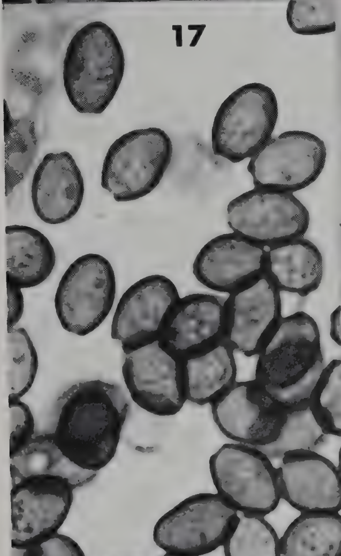
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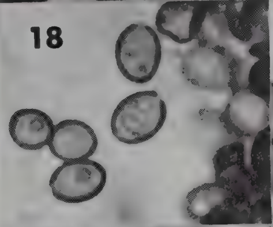
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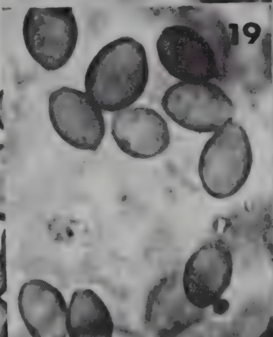
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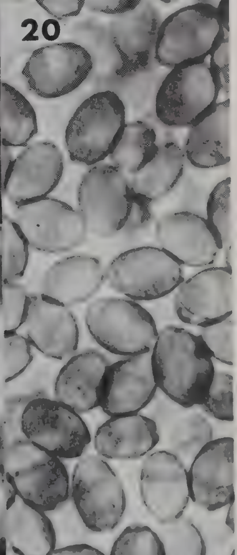
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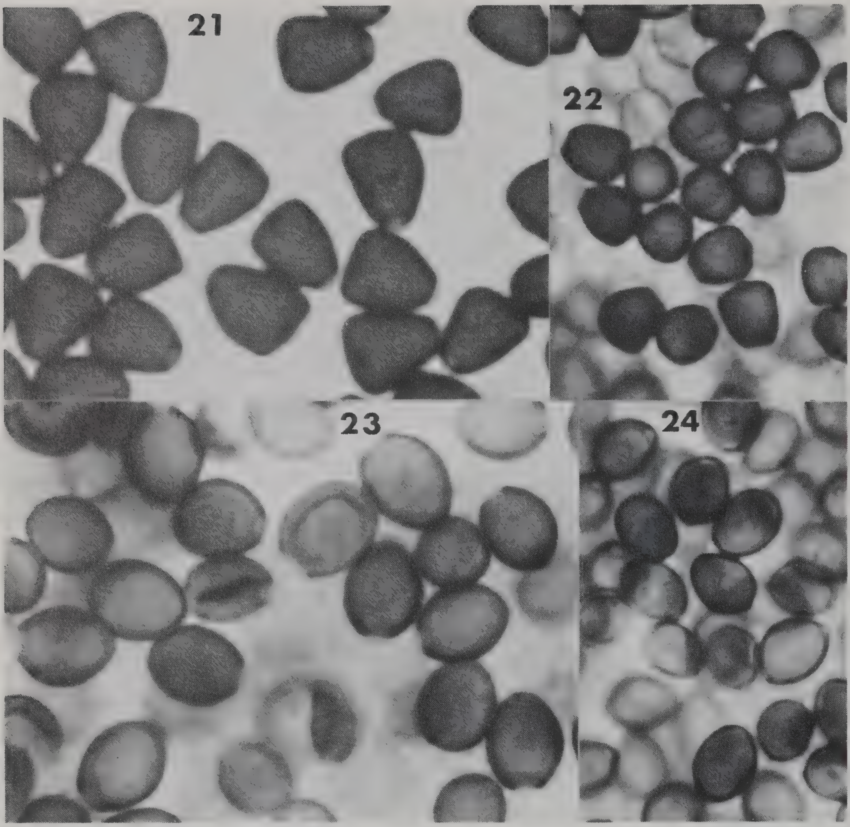

Figs. 21-24. Basidiospores. 21, *C. maysoidisporus* DAOM 175231. 22, *C. argenteus* Type at K. 23, *C. tigrinellus* Type at PC. 24, *C. subtigrinellus* Type at K. All ca. 1,200 X mag.

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culture made from basidiocarps on wood, 4.5 mi. S of Clinton, by Hwy. 97, July 24, 1964, L. Broome & N. Corfman (Anastasiou A 261 = DAOM 128359, type *C. amphibius*).

An isolate of *Coprinus kubickae* from turf grass in Saskatchewan was recently described by Redhead & Smith (1981). A subsequent study of the type of *C. amphibius* indicates that it is conspecific. Spore size (fig. 67), colouration, reaction in H_2SO_4 solution, and shape are identical. Veil tissues (fig. 68) are similar although the hyphae are less inflated on the average in the type of *C. amphibius*. The habitat differs as *C. amphibius* was described on wood in alkaline lakes whereas *C. kubickae* is normally on herbaceous material. A wetland habitat and possibly a basic substrate is common to all collections known. This includes a collection from intertidal salt marsh plant debris, on both woody twigs and grass from Willapa Bay, Washington, U.S.A., Mar. 13, 1971, described by Van de Bogart (1975) under the unpublished and provisional name, "_Coprinus willapaensis_" which appears to be _C. kubickae._

*_Coprinus maysoidisporus_ Redhead & Traquair, _sp. nov._ Figs. 21,28,30, 31-33,35,37,43.

Pileus 4.5-7.0 mm alt., conicus demum planus, candidus, squamatus; squamae brunneae, floccosae. Lamellae librae, candidae demum atrae, approximatae. Stipes 6-21 mm long., 0.5-1.0 mm crassus, candidus, glaber vel floccosus. Sporae 7-9 X 6-7.6 X 5.1-5.3µm, atrae, pellucidae, angulatae vel maysoidiformis, laeves; apiceum poro germinativo; tunica crassa. Pleurocystidia 76-94 X 32-37µm, fusiformis, hyalina. Hyphae veli, ramosae; tunica hyalina, incrustata fusce.
Holotypus: in solum prope Medicaginem sativam, DAOM 175231.

PILEUS paraboloid-conical, 4.5-7 mm high when unexpanded, whitish, with pale umber-coloured to pallid appressed floccose scales mostly in the central region, becoming convex and greyish with age, shallowly plicate-striate; edges eroding. LAMELLAE ascending, nearly free, white becoming fuscous black, crowded, deliquescing with age. STIPE 6-21 mm long, 0.5-1.0 mm wide, subequal, white, nearly glabrous to slightly fibrillose-floccose, with a slightly flattened swollen base.

PILEAR VEIL ELEMENTS: loosely interwoven, only slightly inflated 5-10µm diam., with a poorly developed coralloid branching pattern, thin-walled, hyaline or brownish in segments where incrusted, clamped, loosely attached to the trama tissue which lacks a well developed pellis. PILEUS TRAMA: hyphae radiating, often inflated with age, 6-18µm diam., thin-walled, hyaline, constricted at septa, smooth. LAMELLAR TRAMA: exceedingly thin, 2-3 hyphae thick; hyphae loosely interwoven, 2.7-5.5µm diam., hyaline, thin-walled, clamped. PLEUROCYSTIDIA: 79-94 X 31-37µm, broadly ellipsoid to ventricose, often forked or dimpled at the apex where embedded in the opposing hymenium, thin-walled, hyaline. CHEILOCYSTIDIA: polymorphic ranging from shorter versions of the pleurocystidia to brachybasidium-like, mixed with or attached to hyaline veil-like elements forming a matted cover on the lamellar edges. BASIDIA: dimorphic, 17-24 X 9.9-10.1µm, 4-spored, broadly ellipsoidal with a short to long narrow pedicel; brachybasidia flattened, swollen, forming a rosette around each basidium. BASIDIOSPORES: 7-9 X 6-7.6 X 5.1-5.3µm, subangular and broadly ovate to cordate or triangular in face view, slightly flattened and elliptic to ovate in profile, similar in shape to the kernels of _Zea mays_, thick-walled, fuscous black in mass, blackish but not opaque under the microscope in H_2O, readily dissolving in concentrated H_2SO_4, with a prominent apical germpore. STIPE HYPHAE: 5-30µm diam., hyaline, with thin to pronounced smooth walls, more inflated internally.

HABITAT and SUBSTRATES: On soil or artificial soil adjacent to _Medicago sativa_ taken from arid environments.

COLLECTIONS EXAMINED: CANADA: _Alberta:_ nr. Brocket, Aug. 17, 1979, J.A.T. 1334b (DAOM 175233); Lethbridge, freezing tests in greenhouse from outdoor plots, April 11, 1979, J.A.T. 1287b, (DAOM 175231, Typus). U.S.A.: *Montana:* Echo Lake, July 19, 1928, C.H. Kauffman (DAOM 89696).

Coprinus maysoidisporus is distinguished by its blackish translucent characteristically-shaped spores and its coralloid, thin-walled, brownish, incrusted veil elements. Its large spore size is the only feature which readily distinguishes it from *C. argenteus*, a species known from one collection in the British Isles. Kauffman's collection was labelled "*Coprinus (triangulospora) n.sp.* Kauff. unpublished". No published record of this collection could be found.

Cultural data follows the taxonomic portion.

**Coprinus psychromorbidus* Redhead & Traquair *sp. nov.* Figs. 1-7,25, 32,36,38-42.

Pileus 4-9 mm alt., 5-12 mm latus, conicus demum planus, candidus, squamatus; squamae brunneae, floccosae. Lamellae librae candidae demum atrobrunneae, approximatae, deliquescentes. Stipes 26-70 mm long, 1-3 mm crassus, candidus, glaber vel floccosus. Sporae (6.4-)7.2-8.8(-9.6) X (4.2)5-6(-7.3)µm atrobrunneae, laeves, ellipsoideae vel ovoideae; apiceum poro germinativo; tunica crassa. Pleurocystidia 65-100 X 15-20µm, fusiformia, hyalina. Hyphae veli, ramosae, flavobrunneae; tunica crassa.
Holotypus: in apicalibus senescentibus Medicaginis sativae, DAOM 179229.

HABITAT and SUBSTRATES: On necrotic or senescent parts of *Medicago sativa* L. (Alta.), *Triticum aestivum* L. (Man.), *Urtica dioica* L. (Man.), *Elymus piperi* Bowden (B.C.), *Agrostis stolonifera* L. (Sask.), *Dianthus* sp. (Ont.) and other herbaceous plants usually in arid macro-environments.

COLLECTIONS EXAMINED: CANADA: *Alberta:* nr. Brocket, Aug. 17, 1979, J.A.T. 1334a (DAOM 175232); Lethbridge, field plots, Sept. 20, 1979, J.A.T. 1341 (DAOM 175228), freezing test materials removed from field plots, April 11, 1979, J.A.T. 1286 (DAOM 175226), J.A.T. 1287 (DAOM 175230), April 17, 1979, J.A.T. 1291 (DAOM 175227), J.A.T. 1292 [Holotypus] (DAOM 179229), also culture from J.A.T. 1292 on horse manure (DAOM 177647). *British Columbia:* 2 km. N. of Vernon, Sept. 25, 1980, S.A.R. 4054 (DAOM 177600). *Manitoba:* Winnipeg, Aug. 3, 1937, coll. unknown (DAOM 189344, 189345). *Saskatchewan:* Saskatoon, in greenhouse material from outdoor plots, Mar. 12, 1981, J. Drew Smith (DAOM 179672). *Ontario:* London area, Sept. 8, 1926, "Emma" [Dearness] (DAOM).

A more detailed description of the basidiomes and cultures based on Alberta collections was presented by Traquair (1980).

Coprinus psychromorbidus is characterized by having thick-walled

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Figs. 25-31. Basidiomes. 25, *C. psychromorbidus* DAOM 177600. 26, 27, *C. urticicola* DAOM 175421. 28, 30, 31, *C. maysoidisporus* DAOM 175231. 29, *C. friesii* DAOM 175138.

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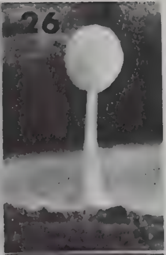

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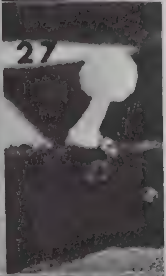

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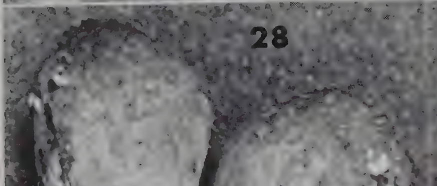

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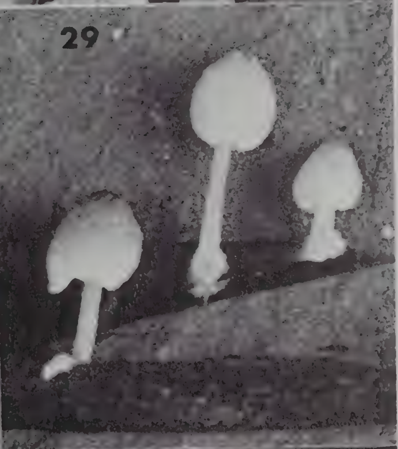

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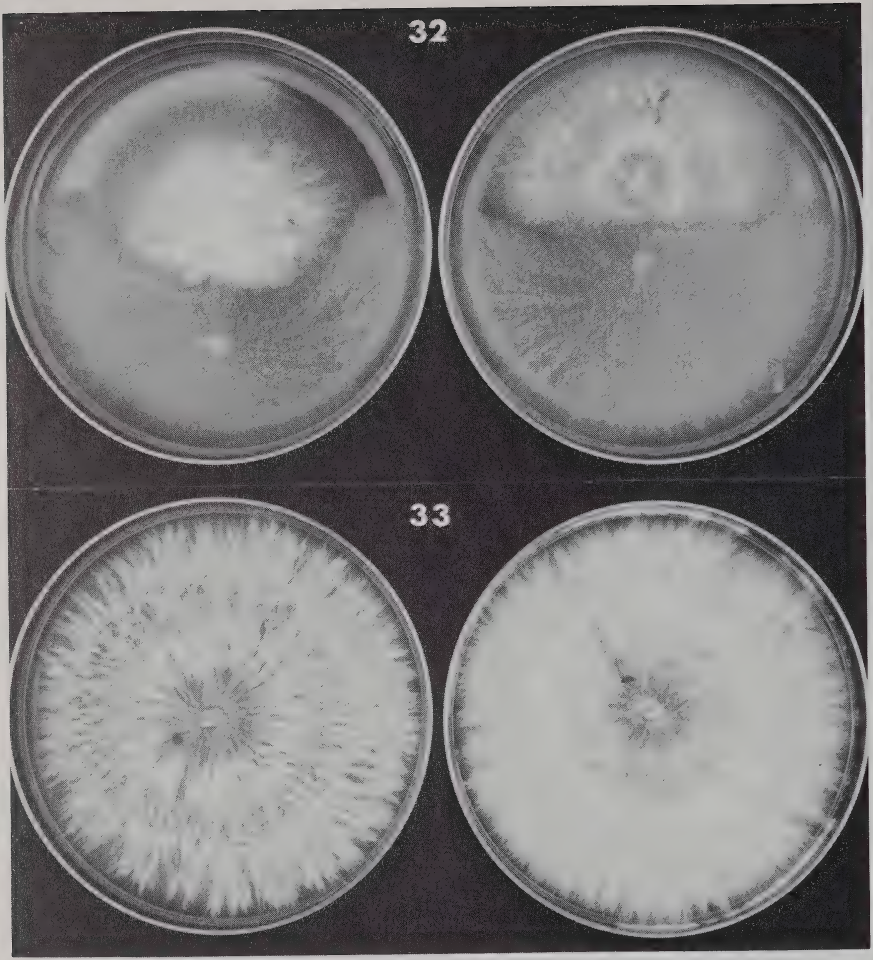

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Figs. 32-33. Mycelia in petri plates. 32, *C. maysoidisporus* DAOM 175237 on upper halves versus *C. psychromorbidus* DAOM 175227 on lower halves. 33, *C. maysoidisporus* on PDA (left) and MA (right) 3 wks.

brownish antler-like veil elements and brown, thick-walled ovoid to ellipsoid spores, mostly 7.2-8.8 X 5-6µm. The size, shape and intensity of the melanization of the basidiospores is quite variable. In the Ontario collection the spores were nearly all ellipsoidal and relatively weakly pigmented, the Manitoba collections have spores with prominently domed adaxial surfaces and in some cases a second germ pore on this raised portion, the British Columbian collection had many misshaped spores, was partially sterile and in general had elongated ovoid spores. The collections from Alberta showed a range in shapes from broadly ovoid to ellipsoidal and in degrees of pigmentation. Cultures from all of the Alberta collections interbred (Traquair 1980). The variation in spore characteristics probably indicates

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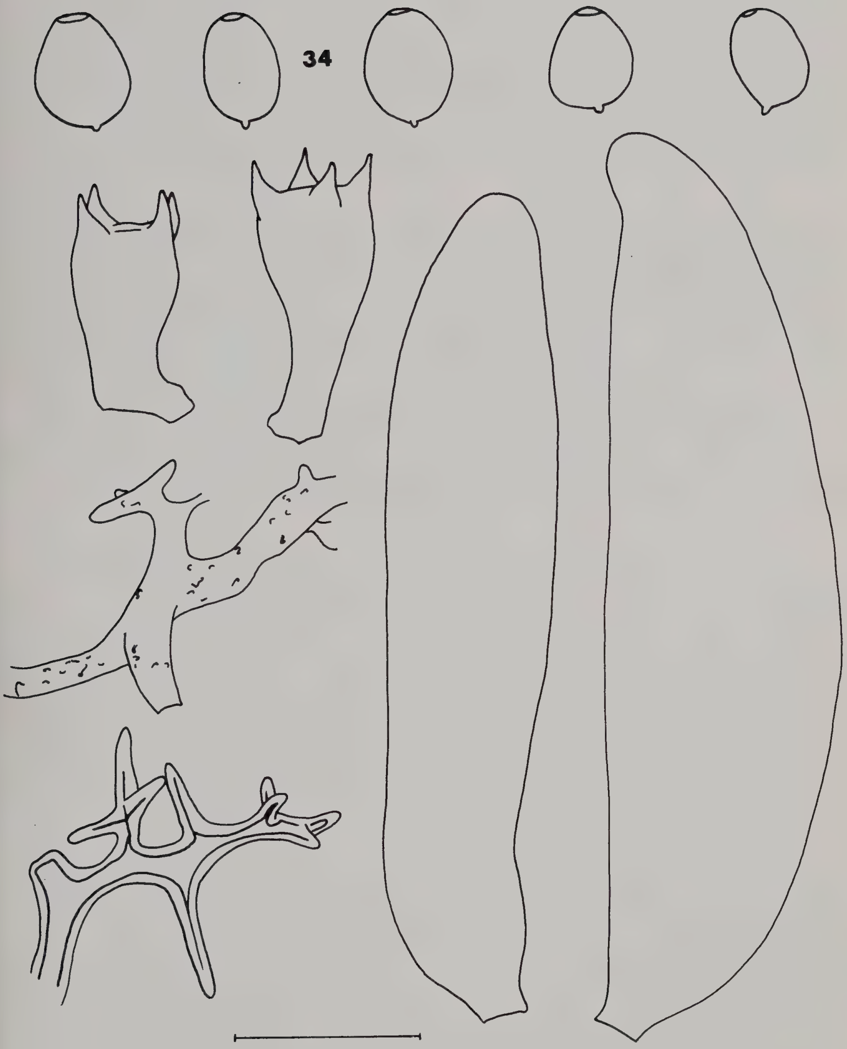


Fig. 34. *C. friesii*, basidiospores, basidia, pleurocystidia, veil elements from pileus, DAOM 177601. Scale = 15µm.

that the species has an unstable gene pool resulting in a high degree of plasticity.

The earliest known collection of *Coprinus psychromorbidus* was made by Mrs. Emma Dearness, the wife of Dr. John Dearness. The collection's label reads, "*Coprinus brassicae*... Emma D. found it on stems of garden pink 8th Sept. 1926," with no additional locality data given. This collection is considered to be from London, Ontario, John Dearness's hometown (Tamblyn 1955) as Dearness collections at DAOM (Parmelee 1978) made at more distant localities are so labelled whereas collections made in the London area usually are not. In addition, J. Dearness, and presumably his wife, had been home in southern Ontario in September 1926 as is evident from his publications (Dearness 1972a,b) and other miscellaneous collections.

Coprinus psychromorbidus was next collected by W.F. Hanna (1939) who reported it as *C. urticicola*. He had earlier cited it as *C. phaeosporus* (Bisby et al. 1938). Hanna's material on wheat and on the nettle collected in July 1937, are not available for study. Two collections labelled *Coprinus brassicae* (a name Hanna considered synonymous with *C. urticicola*) made on herbaceous stems collected behind the Dominion Rust Research Laboratory, Winnipeg, in Aug. 1937 by an anonymous collector are *C. psychromorbidus*. Also, Hanna's (1939) description, line drawings and photographs of the collections on wheat indicate that he had *C. psychromorbidus* and not *C. urticicola* or any other species. Thus Hanna was the first to describe the species in culture and recognize that it might be of importance to agriculture although he could not demonstrate any pathogenicity.

Coprinus psychromorbidus was finally linked to snow mold damage when dikaryotic-monokaryotic matings were made between sterile isolates of the causal agent and single spore isolates from basidiocarps of the *Coprinus* from Alberta (Traquair 1980, 1981). The presence of one pathogenic species in section *Herbicolae* raises the possibilities that other species are pathogens. *Coprinus kubickae*, was found to be associated with superficial fairy rings on turf in Saskatchewan and is possibly the causal agent (Redhead and Smith 1981). Alternatively, the turf damage may have been caused by *C. psychromorbidus*, or *C. kubickae* in combination with *C. psychromorbidus* as the last species has also been isolated from the affected turf (see specimens examined).

Coprinus psychromorbidus appears to be closely allied to the European *C. phaeosporus* Karsten. Its spores are smaller, fall within a narrower range, and the shape is more constant probably as a result of the small size. *Coprinus psychromorbidus* and *C. phaeosporus* probably represent a vicarious species pair derived from a common ancestral circumpolar population. The main difference is spore size and that being highly variable for the former although not to the extent of overlapping. In the same way that *C. psychromorbidus* is a large-spored equivalent of *C. phaeosporus*, *C. maysoidisporus* is a large-spored equivalent of *C. argenteus*. These last two species otherwise being nearly identical in habit, habitat and morphology, also can be considered as a vicarious species pair. In the cases of *Coprinus friesii*, *C. urticicola* and *C. kubickae* which are all found on both continents, more stable gene pools must be involved.

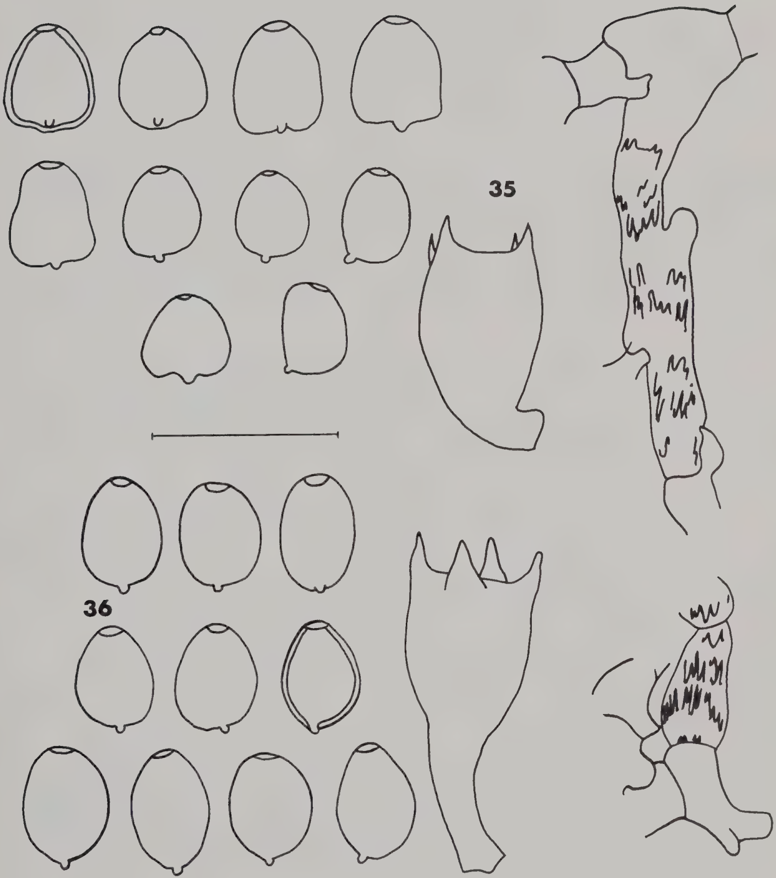


Fig. 35. *C. maysoidisporus*, basidiospores, basidia, veil elements from pileus, DAOM 175231. Fig. 36. *C. psychromorbidus* basidiospores, DAOM 179229. Scale = 15µm.

Other closely allied species are *C. herbivorus*, differing by angular spores, and *C. cinchonensis* (q.v.), differing by large spores.

**Coprinus urticicola* (Berk. & Br.) Buller (1917: 485) Figs. 17-19,26, 27,56-62,69.

≡ *Agaricus urticicola* Berkeley & Broome (1861: 376) *ut "urticaecola"* (Art. 73.8, Stafleu *et al.* 1978).
≡ *Psathyra urticicola* (Berk. & Br.) Saccardo (1887: 107).
= *Coprinus brassicae* Peck (1890: 64)
= *Coprinus melo* Favre (1948: 215)
= *Coprinus suburticicola* Pilát & Svrček (1967: 140)

PILEUS 3-4 mm high unexpanded, paraboloid-conical to nearly hemispherical, white, nearly opaque, minutely pulverulent, becoming plane with revolute torn edges, greyish sepia with age. LAMELLAE nearly free, crowded, white, becoming greyish sepia with age, deliquescing slightly. STIPE 6-11 mm long, 0.1-0.4 mm wide, subequal, fistulose, white, minutely floccose to nearly glabrous, arising from a basal disc with a sparse fringe of tapering mycelial strands.

PILEAR VEIL ELEMENTS: loosely interwoven, with a poorly to moderately developed coralloid branching pattern, little inflated, 5-10µm diam., thin-walled, hyaline, sometimes with refractive hardened drop-like incrustations, simple-septate; loosely attached to the trama tissue which lacks a well developed pellis. PILEUS TRAMA: exceedingly thin; hyphae radiating, thin-walled, hyaline, 2-5µm diam., little inflated, simple-septate. LAMELLAR TRAMA: exceedingly thin, 2-3 hyphae thick; hyphae interwoven and often septate forming a nearly pseudoparenchymatous tissue, 2-5µm diam., hyaline, thin-walled. PLEUROCYSTIDIA: abundant, scattered, 65-88 X 16-24µm, fusoid to ventricose, thin-walled hyaline. CHEILOCYSTIDIA: polymorphic, varying from shorter pleurocystidia-like elements to swollen brachybasidium-like elements and veil-like elements binding the lamellae edges together. BASIDIA: dimorphic 13-22 X 6.5-7.0µm, 4-spored, subglobose to utriform, with a short to long narrow pedicel, simple-septate. BASIDIOSPORES: 5.5-8 X 3.9-5.1µm, narrowly to broadly ellipsoidal to obscurely ovoid, sometimes approaching subglobose in shorter spores, slightly inequilaterally flattened on the adaxial surface, smooth, thin to very slightly thick-walled, pale brown under the microscope, sepia in mass, with a prominent transverse to tangential apical germ pore. STIPE: hyphae parallel, more inflated internally, 14-15µm diam., thin-walled, hyaline, smooth.

HABITAT and SUBSTRATES: On *Carex* (Que.) or grass leaves in wet open fields.

COLLECTIONS EXAMINED: CANADA: *Québec:* Cantley, June 24, 1979, S.A.R. 3490 & J.H. Ginns (DAOM 175421), June 29, 1980, S.A.R. 3518 & J.H. Ginns (DAOM 177602). CZECHOSLOVAKIA: Horní Slověnice pr. Lomnice nad Lužnici, Bohemiae, July 14, 1962, M. Svrček & J. Kubička (PRM #567917, type for *C. suburticicola*). ENGLAND: Kew, July 24, 1957, D.A. Reid (DAOM 66599, ex K). ITALY: Athesis fl. (= Adige River), Sept. 1900, G. Bresadola (NY). SWITZERLAND: Jura vaudo's

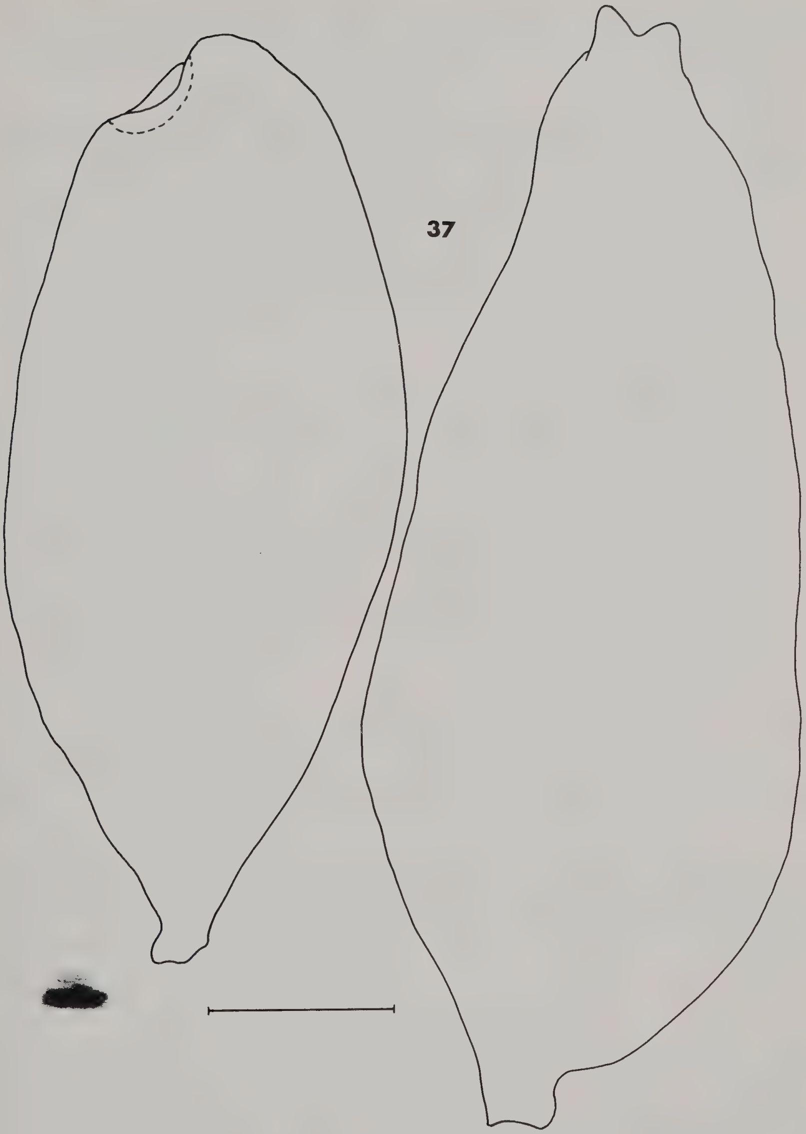


Fig. 37. *C. maysoidisporus*, pleurocystidia, DAOM 175231.
Scale = 15μm.

vallée de Joux, prés du Sentier, Rière la Côte, Aug. 28, 1939, J. Favre (G, type of *C. melo*). U.S.A.: *New York*, Albany Co., Menands, Aug. C.H. Peck (NYS, type for *C. brassicae*); Bronx, June 15, 1911, W.A. Murrill (NY).

The type of *Agaricus urticicola*, the basionym of *Coprinus urticicola*, was unavailable for study because of its fragmented nature. Orton (Dennis, Orton & Hora 1960: 222; Orton 1960: 410) illustrated and described the spores from the type as ellipsoidal, 6-8 X 4.5-5.5μm, with an apical germ pore. This is in rough agreement with Cooke's (1886) illustration from the type collection showing ellipsoidal to obscurely ovoid spores, 7 X 4μm. The combination of spores of this type and a pure white pileus for a European *Coprinus* in section *Herbicolae* indicates that the name should be applied to the species as accepted here.

The types of *Coprinus brassicae* (Figs. 19,58), *C. melo* (Figs. 20,57) and *C. suburticicola* (Figs. 17,59) all have hyaline, thin-walled coralloid veil elements and ellipsoid to obscurely ovoid brownish spores with a prominent apical germ pore. *Coprinus brassicae* is clearly synonymous with *C. urticicola*. Many of the spores of *C. suburticicola* are larger than typical *C. urticicola* but the ranges overlap too much to allow maintaining them as separate taxa. The position of the germ pore is also too variable. *Coprinus melo* differs mainly in the gross appearance of the pileus, having prominent rib-like folds suggesting a type of melon. The microscopic features are identical to typical *C. urticicola*. The type of *C. melo* would seem to be a growth form of *C. urticicola* possibly effected by the high altitude environment.

Coprinus urticicola has been reported on *Brassica oleraceae* L. and *Zea mays* L. in the U.S.A. (Peck 1980 & Murrill 1912, as *C. brassicae*) and on *Urtica dioica* L., *Carex*, *Juncus*, branches of *Picea abies* Karst. and various grasses including *Phalaris arundinacea* L. and *Agropyron* species in Europe (Pilát & Svrček 1967).

The report of *Coprinus urticicola* from Manitoba by Hanna (1939) was based on material of *C. psychromorbidus* (q.v.). Pegler's (1977) report from east Africa is based on *C. paleotropicus* (q.v.) and the Venezuelan collection reported by Dennis (1961) is *C. neotropicus* (q.v.).

EXTRALIMITAL SPECIES

**Coprinus argenteus* Orton (1972: 139) Figs. 22,51.

COLLECTION EXAMINED: ENGLAND: Surrey, Mickleham, Juniper Hill, June 22, 1956, C. Kemball (K, type).

This is the European small spored equivalent of *C. maysoidisporus*. It has blackish but translucent spores readily dissolving in concentrated H_2SO_4. The spores are identical in shape to *C. maysoidisporus*, but are smaller, 5.5-6.5 X 5.0-5.2 X 4.5-4.8μm. The veil elements are moderately to poorly coralloid, essentially thin-walled and hyaline with patches of hyphae bearing a thin brownish incrustation.

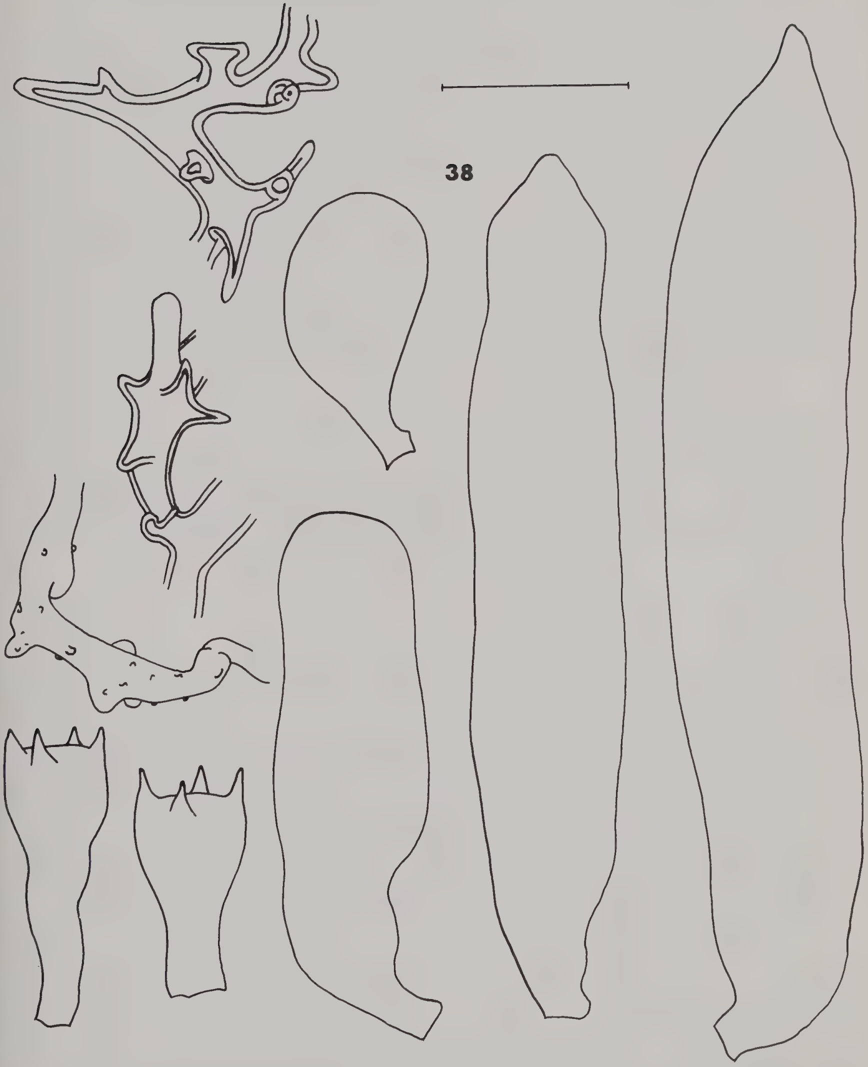


Fig. 38. *C. psychromorbidus* veil elements, cheilocystidia (center), pleurocystidia, basidia, DAOM 179229. Scale = 15µm.

The habitat is on grass in chalkland grasslands.

**Coprinus austrofriesii* Redhead & Pegler, *sp. nov.* Fig. 55.

Differt a Coprino friesio sporis ovoideis 9.6-11.8 X 7.2-8 X 7-9µm.
Holotypus: in graminis, Iulio 11, 1958, Los Palos Grandes (Caracas) Edo, Miranda, Venezuela, leg. R.W.G. Dennis 1495 (K).

Coprinus austrofriesii was reported from Venezuela as *C. friesii* by Dennis (1961: 120). Dennis evidently noted a difference between his collection and European materials as he suspected it would be segregated at the species level in time. It differs from *C. friesii* by the much larger spores. In other respects it resembles *C. friesii.* This is an important difference when compared to the consistency shown between European and North American collections of *C. friesii.*

**Coprinus burkii* Smith in Smith & Hesler (1946: 178).

The type of this species was not studied. This species is essentially *C. phaeosporus* (q.v.) but with hyaline veil elements which have thinner walls towards the extremes of the branches than in *C. phaeosporus.* The habitat is on fern petioles in Alabama.

**Coprinus cinchonensis* Murrill (1918: 85) Fig. 54.

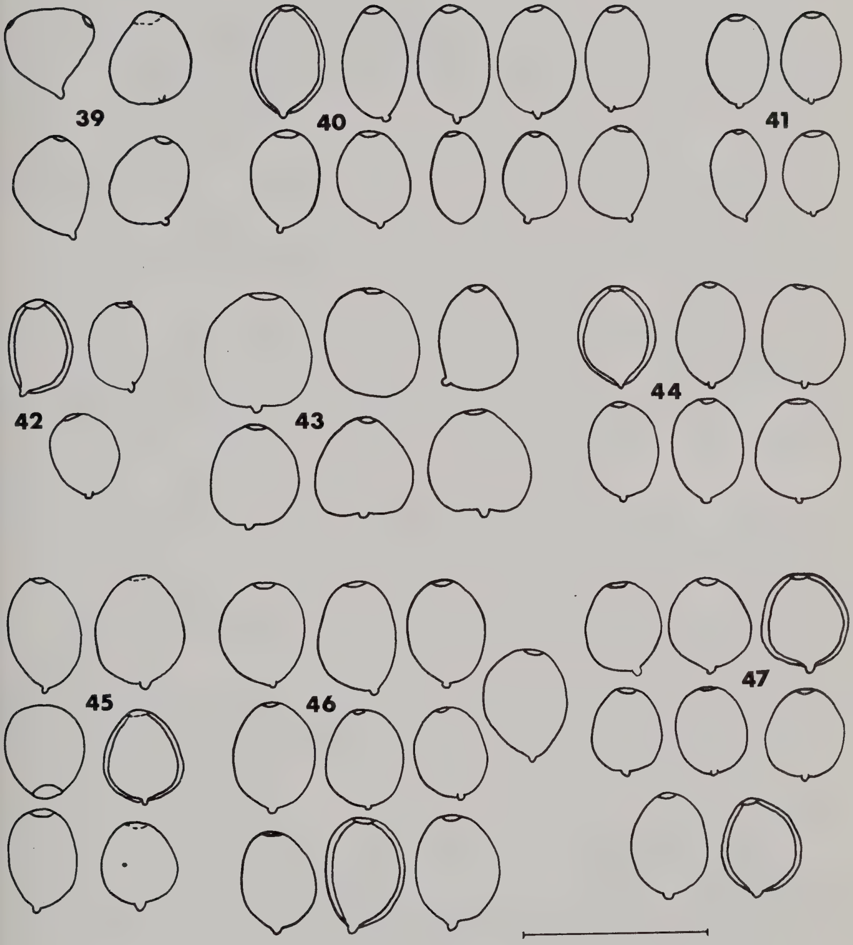
COLLECTION EXAMINED: JAMAICA: Cinchona, 4500-5200 ft. level, Dec.25-Jan. 8, 1908-9, W.A. & E.L. Murrill 579 (NY, type).

Very little is known about this species whose name is based on a single basidiome. The fact that it grew on a log may indicate that it is a peripheral species to the section *Herbicolae*, however, our and Smith's (1948) type studies showed that the microscopic features are very similar to the fungus described here as *C. psychromorbidus.* Murrill's species differs by having larger spores, 9-11 X 5-6 X 6-7.5µm and by the lignicolous habitat. The veil elements are slightly paler yellow than most *C. psychromorbidus* veil elements.

**Coprinus herbivorus* Singer (1973: 70) Figs. 15,49.

COLLECTION EXAMINED: ARGENTINA: Jujuy, Lagunas de Yala, Feb. 9, 1965, R. Singer T3929 (F1015235, type).

Singer (l.c.) gave a detailed description of this species. The angularity of the spores, the most characteristic feature of this species, varies from prominent to obscure. Veil elements with a prominent linear axis from which branched elements arise also characterize *C. herbivorus.*



Figs. 39-47. Basidiospores. 39, *C. psychromorbidus* DAOM 189345. 40, *C. psychromorbidus* DAOM 177600. 41, *C. psychromorbidus* ex Dearness DAOM. 42, *C. psychromorbidus* DAOM 175239. 43, *C. maysoidisporus* DAOM 89696. 44, *C. friesii* DAOM ex Lundell & Nannfeldt. 45, *C. rhombisporus* Type at E. 46, *C. friesii* DAOM 175188. 47, *C. saichiae* Type at K. Scale = 15μm.

Coprinus herinkii Pilát & Svrček (1967: 137) Figs. 8,66.

COLLECTION EXAMINED: CZECHOSLOVAKIA: southern Bohemia, Černoháj nr. Vodňany, Aug. 12, 1938, J. Herink (PRM 499770, type).

Only one collection of this species is known but it seems distinct enough to warrant recognition. The small subglobose spores with apical wrinkles and patches, if found to be a consistent character, will readily distinguish it from all other taxa.

Coprinus neotropicus Redhead & Pegler, *sp. nov.* Fig. 53.

Differt a Coprino urticicolo sporis ellipsoideis vel ovoideis 8-9.5 X 6.5-7.5µm.
Holotypus: in Bambuseis, Iulio, 4, 1958, El Avila, Dts. Federal, Venezuela, leg. R.W.G. Dennis 1136 (K).

Coprinus neotropicus was reported from Venezuela as *C. brassicae* by Dennis (1961: 118-119). As with *C. austrofriesii* (q.v.) he suspected that the collection would be segregated from the northern taxon. *Coprinus neotropicus* differs from *C. urticicola* by having larger spores. It is, in other respects, very similar to the latter species.

Coprinus paleotropicus Redhead & Pegler, *sp. nov.* Fig. 52.

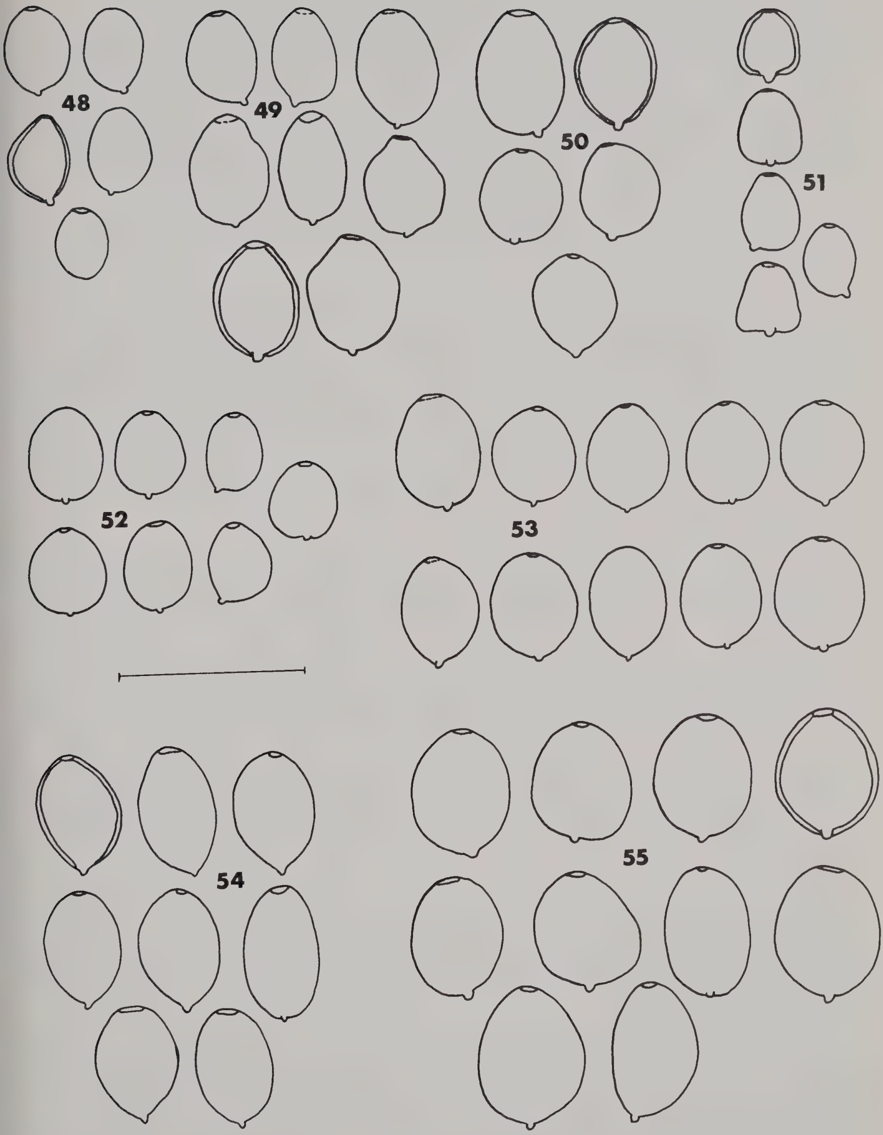
Differt a Coprino urticicola sporis ovoideis, 6.1-8 X 4.5-5 X 5.8-6.7µm, tunicis, crassis.
Holotypus: in ligno, Martio 25, 1968, Nyanza Prov., Kericho reg., Kigumu fl., Kenya, leg. D. Pegler 234 (K). *Paratypus:* Pegler 368.

Coprinus paleotropicus is well described and illustrated as *C. urticicola* by Pegler (1977: 397-399). It differs from *C. urticicola* by having more prominently ovoid, thicker-walled spores and by the woody substrate.

Coprinus phaeosporus Karsten (1881: 9) Figs. 9-12,63-65.
≡ *Coprinopsis phaeosporus* (Karsten) Karsten (1881b: 27)
= *Coprinus pseudofriesii* Pilát & Svrček (1967: 140-141)
= *Coprinus xantholepis* Orton (1972: 150)

COLLECTIONS EXAMINED: CZECHOSLOVAKIA: central Bohemia, Praha-Divoká, July 22, 1941, J.A. Herink 332/41 (PRM 626346, type of *C. pseudofriesii*). FINDLAND: southern Tavastia, Tammela, Mustiala, Aug. 5, 1880, P.A. Karsten 1602 (H, lectotype of *C. phaeosporus*). SCOTLAND: Aberdeenshire, Loch Skene, Aug. 19, 1964, P.D. Orton (E, type of *C. xantholepis*).

The data for the collection which was designated as lectotype and illustrated by Horak (1968) agrees well with that of the protologue (Karsten 1881) and a subsequent description (Karsten 1881c), i.e. Mustiala, in terra stercoratis, 5 Aug. 1880. The type



Figs. 48-55. Basidiospores. 48, *C. subtigrinellus* Type at K. 49, *C. herbivorus* Type at F. 50, *C. tigrinellus* Type at PC. 51, *C. argenteus* Type at K. 52, *C. paleotropicus* Type at K. 53, *C. neotropicus* Type at K. 54, *C. cinchonensis* Type at NY. 55, *C. austrofriesii* Type at K. Scale = 15µm.

consists of a number of basidiomes, some cespitose on grassy debris. As noted by Horak (1968) and Pilát & Svrček (1967), the spores (Figs. 12,65) from the extant basidiomes are smaller, 5.5-7 X 5.5-6μm, and shaped differently from what Karsten had observed, i.e. 9-15 X 5-9μm. This discrepancy is best explained, as suggested by Pilát & Svrček (l.c.), by assuming that Karsten had a mixed collection and what now remains, represents only one of the species represented in the original collection. Thus the species as lectotypified is one characterized by having veil elements with a well developed antler-like branching pattern, thick, golden to hyaline refractive walls, and brownish thick-walled spores which are broadly ovate in face view and slightly compressed, inequilateral and with a nearly lateral apiculus in profile.

The name *Coprinus xantholepis* (Figs. 10,11,64) is based on a collection with essentially identical features to *C. phaeosporus* as is *C. pseudofriesii* (Figs. 9,63). There is a slight difference in the degree of pigmentation of the spores in the three types but not enough to segregate them into different taxa, especially when one considers the variation observed in compatible strains of the allied *C. psychromorbidus*. The report of *C. phaeosporus* from Manitoba (Bisby et al. 1938) is based on *C. psychromorbidus* (q.v.).

**Coprinus subtigrinellus* Dennis (1961: 122-123) Figs. 24,48.

COLLECTION EXAMINED: VENEZUELA: Caracas, Botanic Garden, June 30, 1958, R.W.G. Dennis 1124 (K, type).

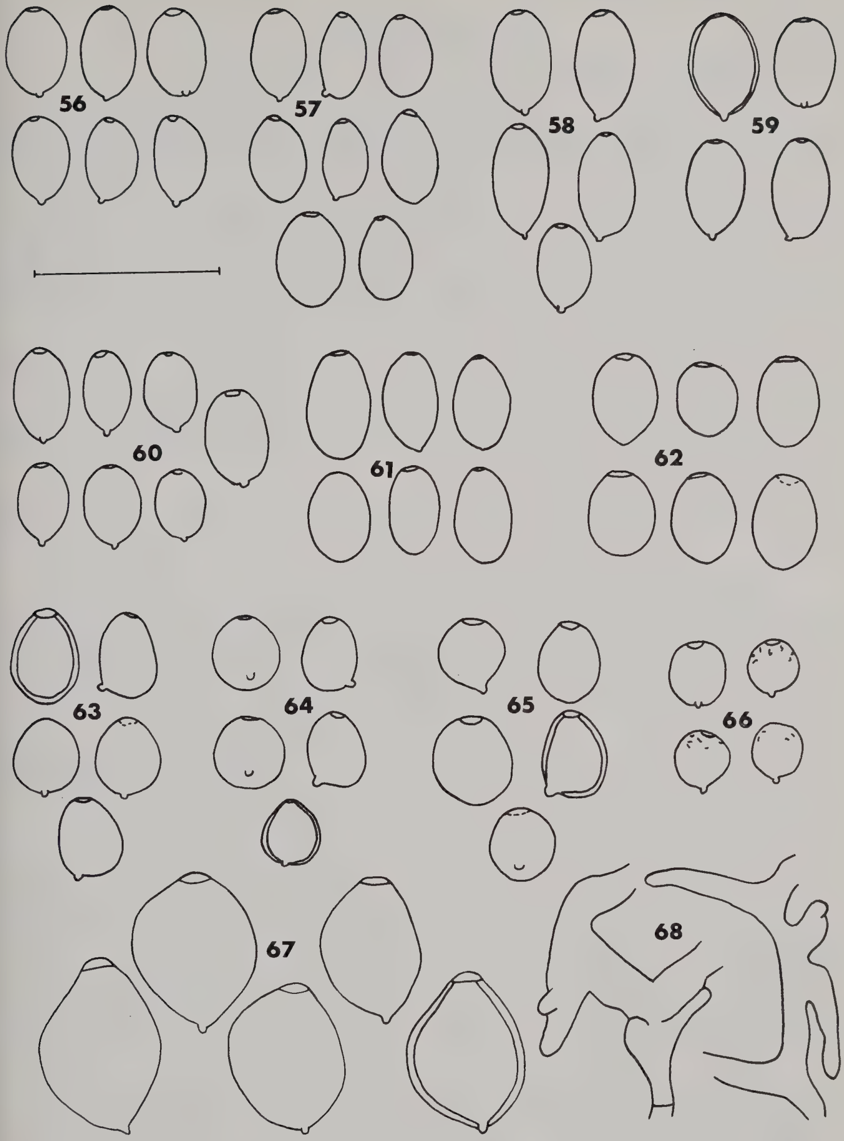
As indicated by the name, *C. subtriginellus* is allied to *C. tigrinellus*, both having veil elements which are brownish, essentially thin walled and coralloid.

Coprinus subtigrinellus differs from *C. tigrinellus* in having smaller spores, 5.7-7 X 4.5-6μm vs. 8-10 X 6.8-7.1μm. Otherwise they are very similar although the former is known from South America and the latter from Europe.

**Coprinus tigrinellus* Boudier (1885: 283) Figs. 23,50.

COLLECTIONS EXAMINED: FRANCE: Montmorency, July 1884, E. Boudier (Lectotype marked "Icones N. 409") plus two additional collections from 1884 and 1890 (PC).

The veil elements of *C. tigrinellus* are not as rounded as illustrated by Boudier (1905-1910) but more like that illustrated for *C. subtigrinellus* by Dennis (1961). The walls are relatively thin and vary from nearly hyaline in some segments to quite darkly melanized in others. They do not become thickened and refractive or golden as in *C. phaeosporus* or *C. psychromorbidus* and they are not roughened by incrustations to the extent that the veil is in *C. argenteus* or *C. maysoidisporus*.



Figs. 56-67. Basidiospores. 56, *C. urticicola* DAOM 66599. 57, *C. melo* Type at G. 58, *C. brassicae* Type at NYS. 59, *C. suburticicola* Type at PRM. 60, *C. urticicola* DAOM 175421. 61, *C. urticicola* NY ex Murrill. 62, *C. urticicola* NY ex Bresadola. 63, *C. pseudofriesii* Type at PRM. 64, *C. xantholepis* Type at E. 65, *C. phaeosporus* Type at H. 66, *C. herinkii* Type at PFM. 67, *C. amphibius* Type at DAOM. 68, Veil elements of *C. amphibius*. Scale = 15µm.

PROBLEMATIC NAMES

Coprinus friesii var. *microspora* J. Lange (1915: 42).

No type collection exists for this name and insufficient data was given in the original description to determine its taxonomic position.

Coprinus microspermus J. Lange (1939: 112), nom. invalid.

This is a nomen nudum, nomen provisiorum and no voucher specimens exist. It is probably the same as *C. friesii* var. *microspora* but no connection was stated.

Coprinus pallidisporus J. Lange (1939: 112), nom invalid.

This is a nomen nudum, nomen provisiorum and no voucher specimens exist.

Coprinus platypus Berkeley in Cooke (1888: 234; 1886: pl. 687B, [675B]).

The type of this species is deposited at Kew. It was described from a collection on palm leaves in conservatories in England and was considered as an alien species. Microscopic details from the type recorded by Dr. D.N. Pegler at Kew (pers. comm.) indicate that the spores are 7.5-9.5 X 6-7.5μm and the veil elements are branched in a manner similar to that for *C. friesii*. The elements have thick hyaline walls and are 1.5-4.5μm diam. Additional observations made by one of us (S.A.R.) on a lamellar fragment indicate the presence of pleurocystidia, an abundance of simple-septa, 4-spored basidia lacking clamps, and brownish slightly thickened walls on the spores. The shape of the spores is subglobose to broadly ellipsoidal.

This species keys out to *C. friesii* and is probably a synonym of that species but the total lack of clamp connections, and the more rounded spore shape without obvious ovoid forms as seen in all other collections of *C. friesii* raise a degree of doubt. Additional collections of *C. friesii* showing more of an intergradation with *C. platypus* should be studied before the latter name is permanently placed in synonymy.

Coprinus phaeosporus var. *solitarius* J. Lange (1939: 111), nom. invalid.

This is a nomen nudum and no voucher specimen exists. Pilat & Svrcek (1967) proposed the combination *Coprinus solitarius* (Lange) Pil. & Svr. based on Lange's variety. However, the combination is based on an invalid name and even though the latin description in Pilat & Svrcek's key couplet might suffice for validation, no type was designated as was required. The name thus remains invalid.

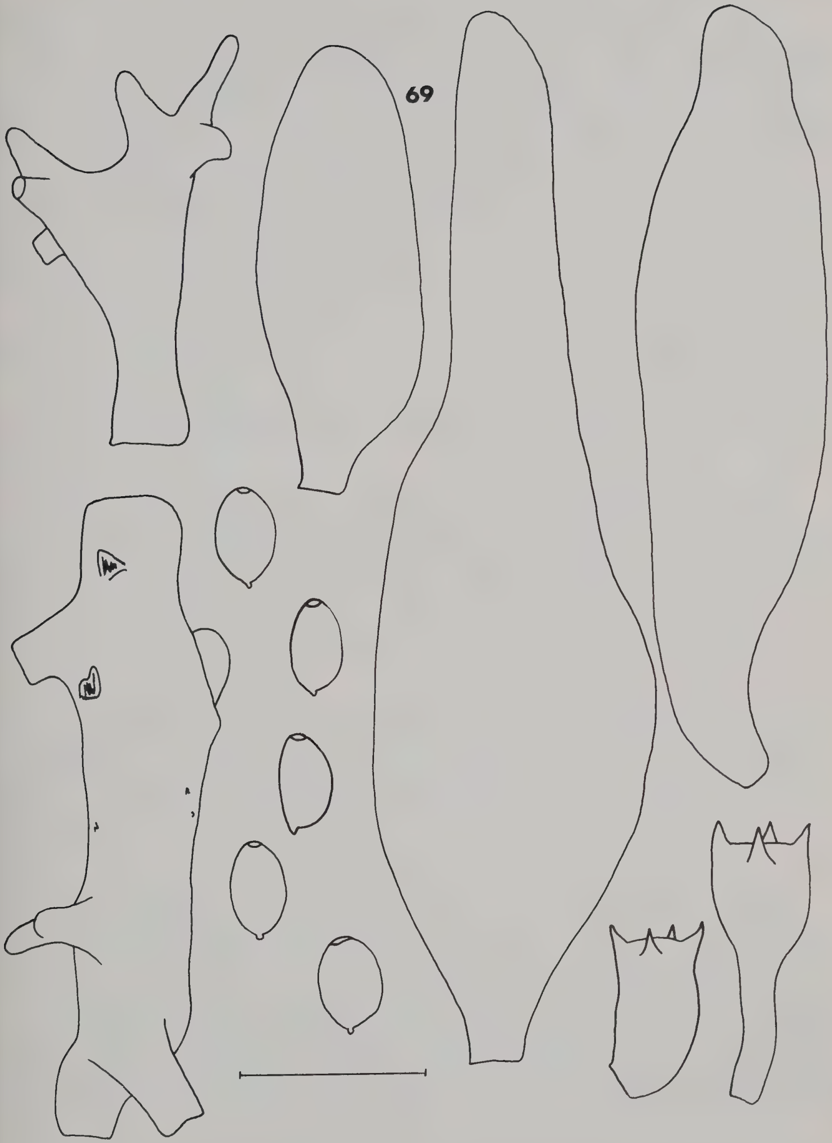


Fig. 69. *C. urticicola*, veil elements from pileus, cheilocystidium, pleurocystidia, basidiospores, basidia, DAOM 177602. Scale = 15µm.

**Coprinus picosporus* Locquin (1955: 13), *C. pusio* Locquin (1955: 16) and *C. romagnesi* Locquin (1955: 14).

These three species no doubt belong in *Coprinus* section *Herbicolae* but insufficient details were published and no types were designated to allow comparisons. In addition, Reid (1958) has noted that the spore sizes given in the text do not correspond with the measurements calculated from data from the illustrations. He suggested that if the magnification stated for the illustrations of spores were changed to 1000X from 2000X there would be consistent correlations. If this were done all three would be taxa distinct from others in section *Herbicolae*. However, if the magnifications given for the illustrations of spores is correct, i.e. 2000X then the spores would be 1/2 the size reported in the text. *Coprinus picosporus* would have spores 4.5-6 X 3.5-4.2µm. Based on spore shape and the thick-walled pigmented coralloid veil elements, *C. picosporus* would become a synonym of *C. phaeosporus*. *Coprinus romagnesi* would have spores 8-9.5 X 6.5-8.5µm and presuming that the veil elements were thick-walled (data not given), then *C. romagnesi* would be synonymous with *C. friesii*. *Coprinus pusio* would have spores 7-8 X 4.5-5µm. Presuming that Locquin's collection had a poorly developed veil, *C. pusio* would be synonymous with *C. urticicola*.

Until the characters to be associated with Locquin's three names can be determined, the use of the names is problematic. Lectotypifiable material may be present in Dr. Locquin's herbarium but this was unavailable during its transfer to the Laboratoire de Micropaléontologie, Paris (Locquin, pers. comm.).

CULTURAL STUDIES

The following information on cultures of *C. maysoidisporus* should be compared with that given for *C. psychromorbidus* (see Traquair 1980). The isolate (DAOM 175231) was obtained by streaking a spore suspension, obtained from a powdered dried basidiome, on potato dextrose agar. The procedures follow Nobles (1965).

Macroscopic description:

Growth moderate to rapid at 22°C, covering 9-cm petriplates in 2-3 wk (8.0 mm/da), with optimal temperature 25°C; advancing zone even to uneven, thin, appressed; aerial mycelium white, appressed to felt-like and somewhat patchy and plumose after 3-4 wk (Fig. 33), occasionally producing yellowish to pale brownish patches of densely matted hyphae after 4-5 wk; surface and submerged mycelium producing white, globose to irregular hyphal knots, 1-3 mm wide, which develop into brownish-black, smooth sclerotia at 6 wk; reverse unchanged in color; odor not distinctive; no evidence of fruiting on malt extract agar or potato dextrose agar.

Tests for extracellular oxidases with gallic acid were positive with no subsequent mycelial growth and were positive, changing color within 2 min with alcoholic gum guaiacum.

Tests for hydrogen cyanide with picric acid solution and PDA as growth medium (Lebeau and Hawn 1963) were negative after 45 da.

Microscopic description:

Hyphae hyaline, thin-walled, noninflated and with clamp connections unless otherwise noted; hyphae of the advancing zone 2.0-3.5μm wide, occasionally branched; hyphae on the agar surface 2.0-4.5(-5.0) μm wide, frequently branched and loosely interwoven after 2 wk, becoming more frequently branched and interwoven after 3-4 wk; submerged hyphae 2.5-4.0(-10.0) μm wide, frequently branched, gnarled, contorted, with globose, elliptical, or irregular swellings and having thin to slightly thickened hyaline to yellowish refractile walls. Hyphal knots and sclerotia compactly interwoven, internal hyphae (medulla) of sclerotia pseudoparenchymatous, 4.0-12.0μm wide, hyaline, thin-walled, inflated, containing granular or oily contents; outer hyphae (rind) of sclerotia plectenchymatous, 4.0-8.0(-12.0) μm wide, yellowish to brown-walled, slightly thickened to thick-walled, cylindrical to irregularly inflated.

Sexuality studies:

Spores from basidiocarps of collection DAOM 175231 germinated in 4-12 h on potato dextrose agar. Hyphae of the monokaryotic, primary mycelium lacked clamp connections but otherwise resembled the dikaryotic, secondary mycelium.

Coprinus maysoidisporus like *Coprinus psychromorbidus*, is heterothallic and is probably bipolar. This pattern is indicated by the complete compatibility of 12 single spore isolates with the dikaryotic isolate in di-mon pairings. Such a result is consistent with findings for other bipolar basidiomycetes (Raper 1966). Tetrapolar species usually have 50% compatibility in intraspecific, intracollection di-mon matings.

The di-mon matings between *C. maysoidisporus* and *C. psychromorbidus* did not result in the dikaryotization of the monokaryotic mycelia, thus supporting the view that two species should be recognized. Monokaryotic mycelium of each species was not dikaryotized by the other *Coprinus* species but was dikaryotized by dikaryotic isolates of the same species. Moreover, colonies of different species failed to merge. The different colonies remained distinct and a confrontation or barrage zone of mounded hyphae developed at the interface between them.

Discussion on the cultural characteristics:

Coprinus maysoidisporus differs from *C. psychromorbidus* in colony morphology and optimal growth temperature. The former produces appressed mats whereas *C. psychromorbidus* produces woolly or cottony mats. Unlike the latter *Coprinus*, the former has a higher temperature optimum (i.e. 25°C) and grows very slowly if at all, at temperatures below 10°C. Furthermore, *C. maysoidisporus* does not produce HCN in culture as does *C. psychromorbidus* (Traquair 1980).

The hyphae of the two species are similar. Although allocyst-like and antler-like branches characteristic of the hyphae of *C. psychromorbidus* were not observed in *C. maysoidisporus*, it would be extremely difficult to distinguish cultures of the two species on the basis of hyphal anatomy.

Whether or not *C. maysoidisporus* is pathogenic is not known at present.

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We thank the following curators and mycologists for their invaluable assistance by the loan of type and other materials: Drs. J. Haines (NYS), B. Spooner, D. Pegler and D. Reid (K), C. Rogerson (NY), D. Henderson and R. Watling (E), H. Harmaja (H), M. Svrček (PRM), O. Monthoux (G), S. Jovet and J. Mouchacca (PC), and P. Ponce de Leon (F). We also wish to thank Dr. J. Ginns for collecting fresh materials and commenting on the manuscript and Dr. M. Locquin for correspondence concerning his collections. J. Drew Smith kindly reviewed the manuscript, as did R. Watling, and provided the Saskatchewan collections of *C. psychromorbidus*. Dr. D. Pegler provided invaluable assistance at Kew. Mrs. M. Meredith typed the final manuscript.

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NOTE ADDED WHEN IN PRESS

A few additional collections from Edinburgh (E) were examined which are of interest. *Coprinus herbivorus* is now known from Australia: Sydney, April 6, 1974, R. Watling Herb. No. 10892, on grass. Two paratypes of *C. rhombisporus* were examined. The earliest, Orton No. 962, July 18, 1956, consists of what appears to be a mixed collection of *C. friesii* with slightly abnormal spores (some slightly rhomboid) and *C. phaeosporus*. The second collection, Orton No. 4134, Aug. 10, 1971, is *C. friesii*.

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SCLEROTINIA BRESADOLAE RICK, A TAXONOMIC SYNONYM OF CIBORINIA CANDOLLEANA (LÉV.) WHETZEL

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Since type or authentic material of Sclerotinia bresadolae Rick (Inoperculate Discomycetes) was unavailable during the author's previous studies of the genus Sclerotinia, no conclusive disposition of the species could be made and the epithet was listed in "A monographic revision of the genus Sclerotinia" (Kohn, 1979), as "imperfectly known." Recently the holotype became available for study and disposition of the species as a taxonomic synonym of Ciborinia candolleana (Lév.) Whetzel can now be made.

Rick (1900) described the species from a collection made in Spring, 1899, on rotting buds of Quercus, many of which were infected by a gall-forming wasp, Dryoteras terminalis. He distinguished the new species from Sclerotinia candolleana Lév., which occurs on leaves of Quercus, primarily on the basis of what he felt was a unique substrate, buds transformed into galls. In addition, he cited the longer stipes and the hairs borne on apothecia and stipes as distinctive.

This species clearly fits within the accepted circumscription of Ciborinia Whetzel. Though hypertrophied due to insect infection, the host is foliar. The ectal excipulum of the apothecium is composed of large-celled textura globulosa. The loaf-shaped sclerotia incorporate host xylem vessels distinguishable by their spirally thickened walls; the medullary cells are dorsiventrally differentiated with the upper zone composed of textura globulosa with gelatinous walls, and the lower zone composed of textura oblita. No conidial anamorph has been observed for this species.

This species also fits within modern circumscriptions of

Ciborinia candolleana. Stipe length is within the range for that species as described by Batra (1960) and, according to Rick's comments on S. bresadolae, is no doubt due to a thick layer of litter covering the sclerotia of this particular population. Batra mentions "rhizoidal tufts present" on the stipe, and stout, rhizoidal hyphae are present at the base of the apothecium, often connecting directly to the sclerotium, in Rick's material. No other "Behaarung" that could account for Ricks description "stipite ... villoso, versus discum fere lanuginoso" is now evident, except for tufts of fine hyphae, originating either from germinating spores or from infection of apothecia by another fungus, seen in some older apothecia examined.

Because particular weight has been placed on host specificity in delimitation of species in Ciborinia, the occurrence of S. bresadolae on Quercus is important. If considered as meristematic leaf tissue, buds and galls are probably not significantly different from the leaves of Quercus, although Rick's specimen appears to represent a rare occurrence of C. candolleana on insect galls.

SPECIMEN EXAMINED: Rick, Majo 1889, "in gemmis Quercus transformatis infectione Dryoteratis terminalis." Holland. [S, ex herb. Bresadola; slide in CUP 59836].

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HALYSIOMYCES, A NEW DEMATIACEOUS GENUS FROM ARIZONA'S SONORAN DESERT

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Clumps and chains of dark-walled, nonsporulating fungus cells are extremely common inhabitants of practically any surface that offers a bit of nutrient. Substrate examples include discarded cellulosic products, painted surfaces, almost every scrap of plant debris overwintered in temperate climates, and the surfaces of living leaves and stems, especially in the tropics but also in temperate climates when aphid secretions and similar nutrients afford support.

Identification of such nonsporulating growths rarely is possible. But the simple expedient of holding a sample in a damp chamber for a day or so frequently induces sporulation and thus enhances the possibility of identification. Species of *Cladosporium*, *Aureobasidium*, and *Alternaria* commonly develop from such materials in temperate climates; other less easily characterized genera also may be found.

Discussed herewith is a species that, judging from its characters in culture, probably will be seen in nature primarily (if at all) as chains and clumps of dark, rounded, thick-walled cells. It grows readily as an isolate on weak potato-carrot agar, hay decoction agar, and 20% V-8 juice agar (hereafter as PCA, Hay, V-8; see Stevens 1974). It produces conidia abundantly and of a septate, catenulate kind that is believed to be remarkable for this heterogeneous group of dematiaceous molds. Inspiration to discuss this species has derived largely from staff publications of the Centraalbureau voor Schimmelcultures (Hermanides-Nijhof 1977; Hoog and Hermanides-Nijhof 1977) and of the University of Alberta Mold Herbarium and Culture Collection (Sigler, Tsuneda and Carmichael 1981), which treat several superficially similar genera.

HALYSIOMYCES Simmons, *gen. nov. Hyphomycetes*
[Gr.: *halysion* + *mykes* = chain-fungus]

Hyphae atrobrunneae, torulosae, ramosae. Colonia atra ut radii discreti vel fila radiata arcte adpressa formata; plerumque in substrato agaro submersa, sed ad centrum aliquantum elevata, convoluta, cerebriformis; aspectu nitido sed nec uda nec mucosa. Hyphae aeriae infrequentes. Conidia ex cellulis hypharum holoblastica, atra, transverse septata, singularia vel distaliter catenata.

Typus: Halysiomyces saxatilis Simmons, *sp. nov.*

Described from axenic culture. Hyphae dematiaceous, torulose, branching. Colony black, developing as discrete radii (on PCA and Hay) or as closely appressed radial elements; mostly submerged in agar substrate, but raised, convoluted, cerebriform in center; appearing shiny on V-8 but not wet or mucoid. Aerial hyphae rare. Conidia holoblastic from hyphal cells, dark, transversely septate, distally catenate.

Halysiomyces saxatilis Simmons, *sp. nov.*
[L.: *saxatilis* = found among rocks]

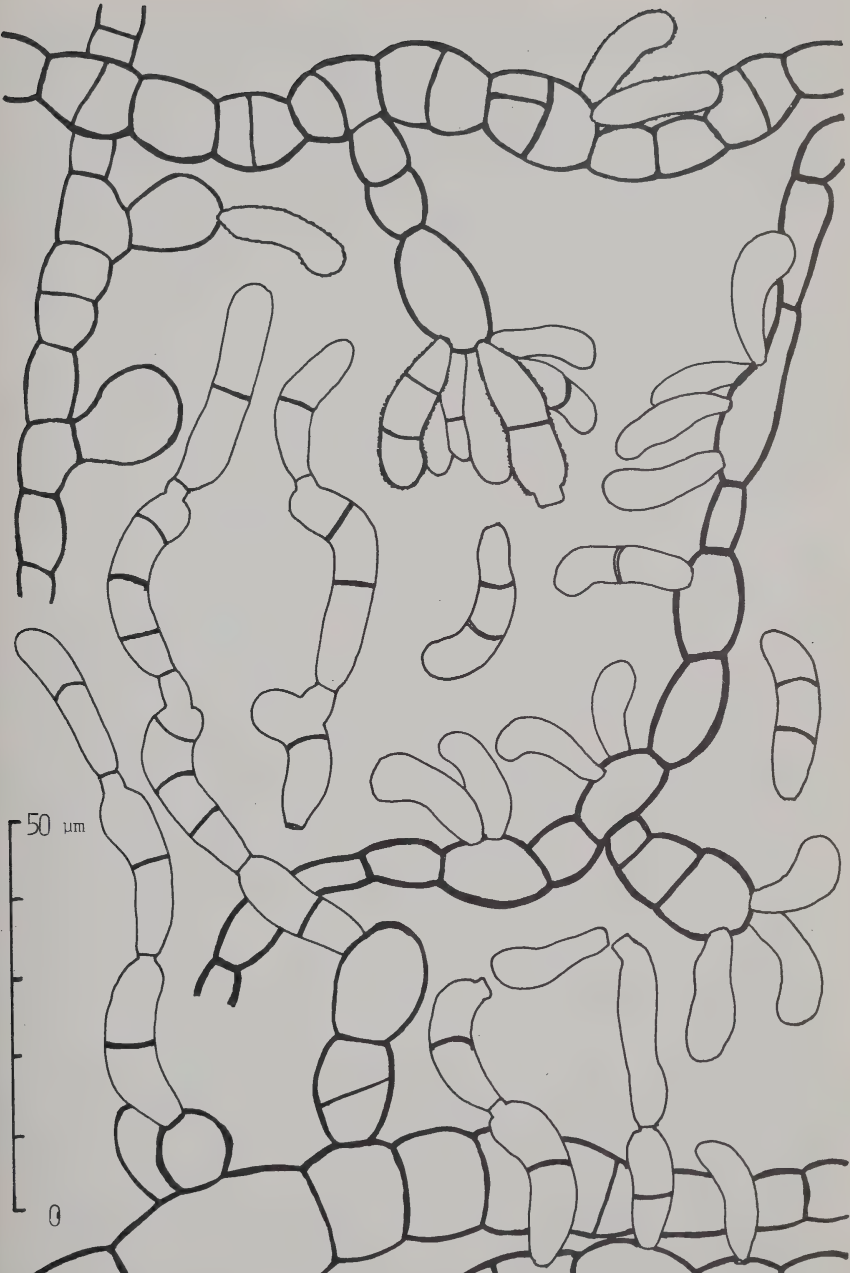
Ex culturis in agaro PCA descripta. Coloniae ut hyphae atrobrunneae, torulosae, ramosae, submersae, valde radiatae formatae. Centrum coloniae convolutum, aliquantum elevatum, hyphis aeriis paucis. Cellulae hypharum laeves, usque ad 6-16µm longae x 16-20µm latae ampliatae. Conidia ex cellulis hypharum radialium et ramulorum lateralium holoblastica, allantoideoclavata, minute aspera, brunnea, 1-3 transverse septata, circa 25 x 4µm, et solitaria et 2-4-catenulata acropeta.

Origo typi: ex aere deserti Sonora prope Phoenix, Arizona, U.S.A., m. Febr. 1980, a J. T. Staley et F. Palmer lecto.

Typus: partes ex Simmons 33-129 desiccatae et in BPI, DAOM, IMI, NY conservandae.

The isolate is described from cultures grown concurrently on PCA, Hay and V-8 juice agars. Radial growth is about 10mm in 7 da at 15-22°C in diurnal light/dark cycles.

Fig. 1. *Halysiomyces saxatilis*. Thick-walled radial and branch hyphae with solitary and catenate conidia produced as submerged elements in PCA.


50 µm
0

Radiating torulose hyphae produced in PCA are distinct and somewhat sinuous; concentric rings of growth correlate with the light-dark regimen; the colony center is slightly raised above the agar surface and is closely convoluted under pressure of progressive septation, enlargement, and hardening of the toruloid elements. The macroscopic appearance on Hay agar is similar to that on PCA except that the radial pattern of growth is less striking than are the medusoid radii produced in PCA. The radial elements produced on V-8 agar are appressed so closely that the colony appears opaque; there is a larger, more obviously convoluted central area of development than is found on PCA; and the agar surface has a dull sheen which, on inspection at low magnification, proves to be light reflected from a network of jetblack, closely septate torulose hyphae resembling millipede integuments or doliiform beads in chains of indeterminate length. Colonies are dry, not mucoid or wet.

Linear hyphal growth is of brown tubular elements that gradually become septate and torulose-swollen at more or less regular intervals; most resultant cells are 10-20μm broad and shorter than wide; a longitudinal septum is laid down in relatively few hyphal cells. Lateral branches of one to many swollen brown cells are numerous throughout the length of the radial hyphae, but they do not obscure the predominantly radial appearance of most colonies. Otherwise undifferentiated cells of radial hyphae and of lateral branches may produce conidia, sometimes only one or two per conidiogenous cell but at other times clusters of 6-10.

Primary conidia are sessile, pale, minutely rough, and slightly enlarged toward the apex; they darken, produce a median transverse septum, and become inequilateral, usually with an abrupt bend near the distal end; at the 1-septum stage they commonly are 25 x 4μm, becoming only slightly, if at all, larger when second and third transverse septa are formed. Conidia may develop a subapical or truly lateral extension 2-3μm wide x 1-3μm long which functions as the site of production of a single holoblastic conidium. Chains of 2-4 or more conidia are produced in this manner; they are easily visible as they are held in position submerged in the agar substrate. Conidium ontogeny appears to be holoblastic in all cases. Conidium release appears to be by wall fracture, a small remnant of conidiogenous cell wall sometimes being visible alongside the bottom contour of a dislodged conidium.

Production of distinctive conidia submerged in agar substrates, as with this fungus, is a striking phenomenon; but, in my experience, it is not unique to this fungus, in that some strains of *Stemphylium* and *Curvularia* have been observed to sporulate abundantly and with typical conidium morphology under such conditions.

Information from isolator J. T. Staley is that this fungus (typified from an air isolate) also has been found in culture plates prepared from swabbings of a material referred to as "rock varnish," which is found on rock surfaces in the cactus-creosote bush region of the Sonoran desert near Phoenix, Arizona, U.S.A.

- o O o -

Margaret E. Barr Bigelow and I had several fruitful discussions on the systematic placement of this isolate. J. W. Carmichael, after reviewing a draft of the manuscript, has commented on unique aspects of the species.

- o -

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OSORIOMYCES, A NEW GENUS OF THE LABOULBENIALES FROM TAIWAN

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SUMMARY

A new species of the Laboulbeniales parasitic on *Osorius formosae* Bernhauer (Coleoptera, Staphylinidae) is described as *Osoriomyces rhizophorus*. *Osoriomyces* is a new genus having an affinity with *Scelophoromyces*; it is characterized by a thallus consisting of a primary axis of superposed cells that terminates in a cluster of appendages; this axis bears sessile perithecia, as well as secondary axes on which short antheridial appendages and perithecia are borne laterally. Rhizoidlike appendages grow downward from a cluster of small cells just above the basal cell of the thallus. The outer walls of the perithecia consist of four vertical rows of four cells each. Although spermatia could not be detected, structures having the appearance of simple antheridia were observed.

During my investigation of the Laboulbeniales of Taiwan, a fungus was found that bore a resemblance to *Scelophoromyces osorianus* Thaxter, which had been collected on *Osorius* in Argentina (Thaxter, 1912, 1931). However, the perithecia of the Taiwanese thalli had very short stalk cells, giving the appearance of being sessile, and the thalli bore secondary axes. Consequently, the following new genus is being described. Both fungus and host specimens are deposited in the Herbarium of Hiroshima University, Hiroshima, Japan (HIRO).

Osoriomyces Terada, gen. nov.

Thallus ex axe primario et axibus secundariis constans. Axis primarius ad apicem appendicem terminalem et secus latera appendices laterales et prope basin rhizoidea gerens. Axes secundarii secus latera appendices laterales gerentes. Cellulae receptaculi praeter cellulas prope basin uniseriales. Perithecia sessilia in axe primario et axibus secundariis lateraliter prodientia. Parietes exteriores perithecii ex seriebus 4-cellularibus quattuor constantes. Antheridia simplicia in appendicibus lateralibus prodientia.

Thallus consisting of primary and secondary axes. Primary axis bearing primary appendage at its apex, lateral appendages along its sides, and rhizoidlike appendages near its base. Secondary axes bearing lateral appendages. Cells of receptacle (except for cells in the suprabasal portion of the primary axis) arranged in a uniseriate row. Sessile perithecia produced laterally on both the primary and secondary axes. Outer walls of perithecia consisting of four vertical rows of four cells each. Simple antheridia produced on lateral appendages.

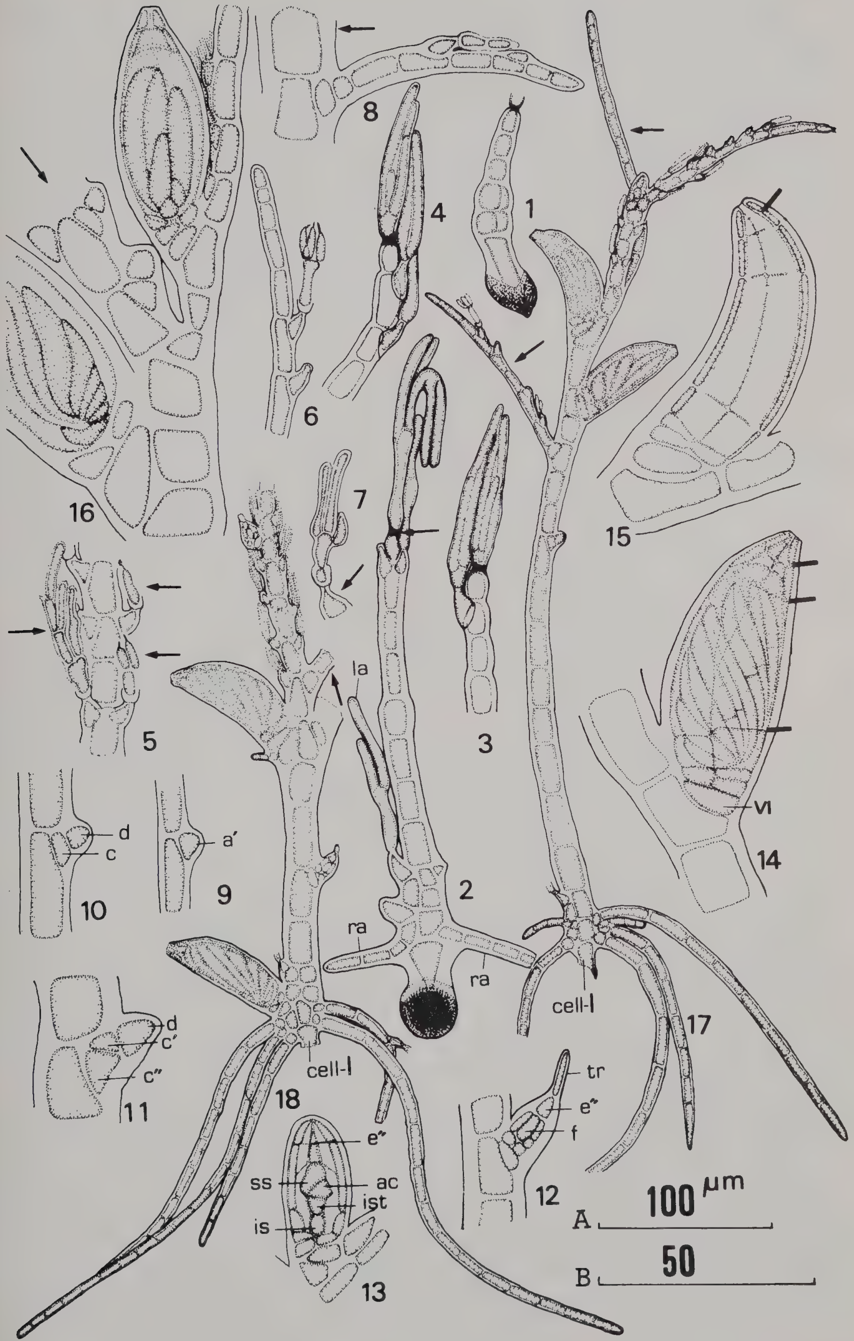
Type species: *Osoriomyces rhizophorus* Terada, on *Osorius formosae* Bernhauer from Taiwan.

Osoriomyces rhizophorus Terada, sp. nov. (Figs. 1-18)

Thallus hyalinus vel leviter luteolus, 320-540 µm longus, in receptaculi 2-5 perithecia gerens. Axis primarius ex 25-35 cellulis superpositis oblongis constans. Axes secundarii ex 8-13 cellulis superpositis oblongis constantes. Appendix terminalis ca. 50 µm longa, plerumque ramosa, gelatinosa, sparse septata, basi septo denigrato constricta. Appendices laterales 26-52 µm longae, simplices vel varie ramosae, gelatinosae, sparse septatae, sursum extensae. Rhizoidea 180-350 µm longa, simplicia, rigidula, clare septata, deorsum extensa. Antheridia ca. 9 µm longa, evanescentia, gelatinosa, solitaria vel fasciculata. Perithecia 60-79 x 24-36 µm, ovata, plerumque extrinsecus curvata, apice truncata.

Thallus hyaline or slightly yellowish, 320-540 µm long (from foot to constricted, dark septum at base of terminal appendage), bearing 2-5 perithecia on receptacle. Primary axis consisting of 25-35 superposed, oblong cells; cells just above cell I undergoing several longitudinal and transverse divisions to form group of cells. Secondary axes shorter and thinner than primary axis, on which they are irregularly arranged, each secondary axis consisting of 8-13 superposed, oblong cells. Terminal appendage ca. 50 µm

Figs. 1-18. *Osoriomyces rhizophorus*. 1. Sporeling with second and third cells divided longitudinally. 2. Young thallus, showing receptacle with two rhizoidlike appendages (ra), a lateral appendage (la), and a terminal cluster of appendages. Arrow indicates blackened septum. 3. Upper portion of primary axis, showing a cluster of appendages; only terminal one bears blackened septum at its base. 4. Upper portion of primary axis, showing a cluster of appendages; terminal one also bears blackened septum at its base. 5. Upper portion of primary axis, showing appendages produced on both sides of each receptacle cell. Left arrow indicates a subdichotomously branched appendage. Right arrows indicate antheridia with or without a one-celled stalk. 6. Upper portion of secondary axis, showing the initiation of an appendage below and a triangular, subsessile cell above bearing a one-celled antheridial branch with three apical antheridia. 7. Short trichotomous appendage. Arrow indicates triangular basal cell. 8. Secondary axis, showing a short, simple appendage. Arrow indicates primary axis. 9-11. Very early stages of perithecial development. Explanation is in text. 12. Young perithecium, showing the female organ, which consists of three cells - a terminal trichogyne (tr), a median trichophoric cell (e"), and a carpogenic cell (f). 13. Immature perithecium at 3-tier stage, showing a trichophoric cell (e"), a superior supporting cell (ss), an ascogenous cell (ac), a secondary inferior supporting cell (ist), and an inferior supporting cell (is). 14. Fully mature perithecium on primary axis, with appressed stalk cell (VI). Lines indicate septa in vertical row of outer wall cells. 15. Mature perithecium in which the fourth tier has divided in one row. Line indicates dividing point. 16. Slightly immature perithecium on secondary axis; primary axis (arrow) bends to left. 17. Thallus with two well-developed perithecia and two secondary axes (arrows). 18. Thallus with two mature perithecia and one young perithecium; five rhizoidlike appendages extend from suprabasal portion of primary axis; gelatinous lateral appendages arise from upper portion of primary axis; secondary axis (arrow) has broken. (Figs. 1-16: scale B; Figs. 17-18: scale A.)


8
4
1
16
6
7
15
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3
14
vi
d
c
a′
10
9
2
ra
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17
d
c′
c″
11
cell-I
18
tr
e″
f
e″
ss
ac
ist
is
13
12
100 µm
A
B
50

long, usually branched, gelatinous, sparsely septate, constricted by blackish septum at its base. Lateral appendages 26-52 µm long, simple or variously branched, gelatinous, extending upward, arising from triangular, subsessile cells formed at one or both upper corners of receptacle cells, these appendages sometimes producing one or more antheridia terminally. Simple rhizoidlike appendages 180-350 µm long, somewhat rigid, extending downward from more or less cubical cells in suprabasal cluster of receptacle cells. Antheridia ca. 9 µm long, evanescent, gelatinous, solitary or clustered, produced directly upon somewhat triangular basal cell or borne on short, one-celled branch. Perithecia 60-79 x 24-36 µm, ovate, usually curved outward and truncate at its apex.

Holotype: TAIWAN. Nantou Hsien, Chitou, at ca. 1300 m alt., No. 783, May 28, 1977, K. Terada leg., on elytra of *Osorius formosae* Bernhauer (Coleoptera, Staphylinidae).

Paratypes: TAIWAN. Nantou Hsien, Chitou, Nos. 782, 784, 786-790, data as for the holotype; Nantou Hsien, Tsuifeng, Nos. 791, 792, July 25, 1972, K. Terada leg., on various parts of body of *Osorius formosae* Bernhauer.

Osorius formosae occurs in mountainous regions of Taiwan, where it lives in rotten wood. It is often found with *Priochirus silvestrii* Bernhauer, host of *Monoicomyces leptochiri* Thaxter (Terada, unpublished). Eight fully mature specimens of *Osoriomyces* and more than ten immature ones were collected from thirteen specimens of *Osorius formosae*. Collection of additional specimens would be necessary for a thorough study of thallus development.

After spore germination, a series of horizontal divisions takes place that results in the formation of a uniseriate thallus having a darkened, constricted septum near its apex, which may break off early (Fig. 1). Vertical divisions soon occur in the lower cells of the thallus, resulting in the formation of a biseriate lower receptacle (Fig. 1). The number of cells in the thallus increase so that in the thallus shown in Fig. 2, there are eight superposed cells separating the constricted, dark septum from the cluster of cells just above the basal cell. Rhizoidlike appendages (ra) extend outward just above the base of the thallus, whereas gelatinous, erect appendages (la) arise laterally at a higher level. The primary axis of the thallus terminates in a cluster of gelatinous appendages (Figs. 2-4) (it was not possible to determine the exact position of the spore septum, which separates the primary appendage from the receptacle). By maturity, five or six simple, long, rhizoidlike appendages are present that extend downward from the suprabasal group of cells in the primary axis (Figs. 17, 18). Triangular, subsessile cells are formed on one or both upper corners of the upper cells of the receptacle. Each of these cells produces a short, gelatinous branch. Secondary axes that arise from the upper part of the primary axis (two are indicated in Fig. 17) may deteriorate later (Fig. 18). The positions of the perithecia are variable; however, the lowermost one usually occurs on the suprabasal portion of the primary axis (Fig. 18).

In the material examined, one specimen bore gelatinous, unicellular, elongate structures directly on triangular, subsessile cells (Fig. 5) or in clusters on a stalk cell produced by a subsessile cell (Figs. 5, 6). Although spermatia could not be detected, these structures are regarded as simple antheridia because they are very narrow apically. Consequently, *Osoriomyces* belongs to the Laboulbeniaceae. The antheridia seem to cease their function in a short time; possibly, they are converted into sterile appendages (Fig. 5, arrow at left; Figs. 7, 8).

During perithecial ontogeny in *Osoriomyces rhizophorus*, a single cell (a') that arises laterally from the receptacle (Fig. 9) soon divides obliquely into an upper (d) and a lower cell (c) (Fig. 10). The lower cell (c) divides into an upper cell (c') and a lower cell (c")(Fig. 11), which undergo further divisions and finally form the perithecial walls. The upper cell (d) produces the female sexual organ, which initially consists of three superposed cells - a lower carpogenic cell (f), a median trichophoric cell (e"), and a terminal trichogyne (tr) (Fig. 12). Only one- or two-celled trichogynes were observed. By the time there are three tiers of outer wall cells, an ascogenous cell (ac) and three supporting cells (ss, ist, is) are present below the trichophoric cell (e") within the perithecium (Fig. 13). This pattern of perithecial development is the same as that described in detail by Thaxter (1896) for *Stigmatomyces baeri* (Knoch) Peyritsch and other taxa.

By the time perithecial wall consists of four tiers of cells, asci have been formed (Fig. 16). The second tier of cells in the fully mature perithecia is 3-4 times taller than the lowest tier (Fig. 14). Sometimes the apical outer wall cell on the inner side of the perithecium (toward the thallus axis) divides (Fig. 15). The stalk cells and the basal cells are strongly appressed to the receptacle so that the perithecia are sessile in appearance (Figs. 14, 15).

The genus *Osoriomyces* cannot be allied with any genus of the Laboulbeniales except *Scelophoromyces* Thaxter (1912; in 1931, Thaxter altered the spelling of this genus to *Skelophoromyces*, but the earlier spelling should be used). *Osoriomyces* resembles *Scelophoromyces* in the following ways: 1) the primary axis consists of a variable number of superposed cells; 2) rhizoidlike appendages arise at right and left from the suprabasal portion of the primary axis; 3) lateral appendages extend upward from one or both upper corners of receptacle cells. On the other hand, remarkable differences exist between the two genera: 1) the perithecia of *Osoriomyces* are normally sessile and lateral, whereas in *Scelophoromyces*, they are long-stalked and never arise directly from any cell of the primary axis; 2) the primary axis of *Osoriomyces* is highly divided in the suprabasal portion, whereas in *Scelophoromyces*, the suprabasal portion is less divided or undivided; 3) lateral appendages of *Osoriomyces* are gelatinous and the protoplasts of their short, subsessile basal cells taper almost to a point apically, whereas in *Scelophoromyces*, they are rigid like the rhizoidlike appendages and the protoplasts of their basal cells are broad at the apex.

ACKNOWLEDGMENTS

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THE GENUS CODINAEA. THREE NEW SPECIES FROM THE AMERICAS

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Three new species of Codinaea Maire are described and illustrated from the U.S.A. and Venezuela. A key modified from Hughes and Kendrick (3) to include those species described since 1968 is also included.

Codinaea illinoensis Hewings & Crane sp. nov. Fig. 1. A and B.

Coloniae effuse, pallide brunneae, demum fusco-brunnescentes. Mycelium in substrato immersum, e hyphis crasse tunicatis, ramosis, septatis, subhyalinis vel pallide brunneis compositum. Setae nullae. Conidiophori macronemati, mononemati, simplices, recti vel paulum arcuati, septati, hyalini vel pallide brunnei, tunicis crassis, levibus induti, singillatim e hyphis vel cellulis nodulosis orti. Cellulae conidiogenae monophialidicae, integratae, terminales, paulum lageniformes, apicem versus tenuiter, prope basim crasse tunicatae, 30-37 x 5.6-6.7 µm. Collarula conspicua, infundibuliformia, expansa, marginem versus tenuiter tunicata, ad basim crasse tunicata, refringentia, 2.3-3.3 x 3.3-4.4 µm. Phialoconidia hyalina, continua vel nonnumquam uniseptata, paulum arcuata, symmetrica, ad apicem attenuata in finem obtuse rotundatum setulam rudimentarium apiculatum exhibentem, ad basim attenuata, cicatrice obtusa notata, 14.4-18.9 x 3.3- 4.4 µm. Typus: ILLS 42169.

Colonies effuse, pale brown becoming dark brown. Mycelium immersed in the substrate, composed of thick-walled, branched, septate, subhyaline to pale brown hyphae. Setae absent. Conidiophores macronematous,

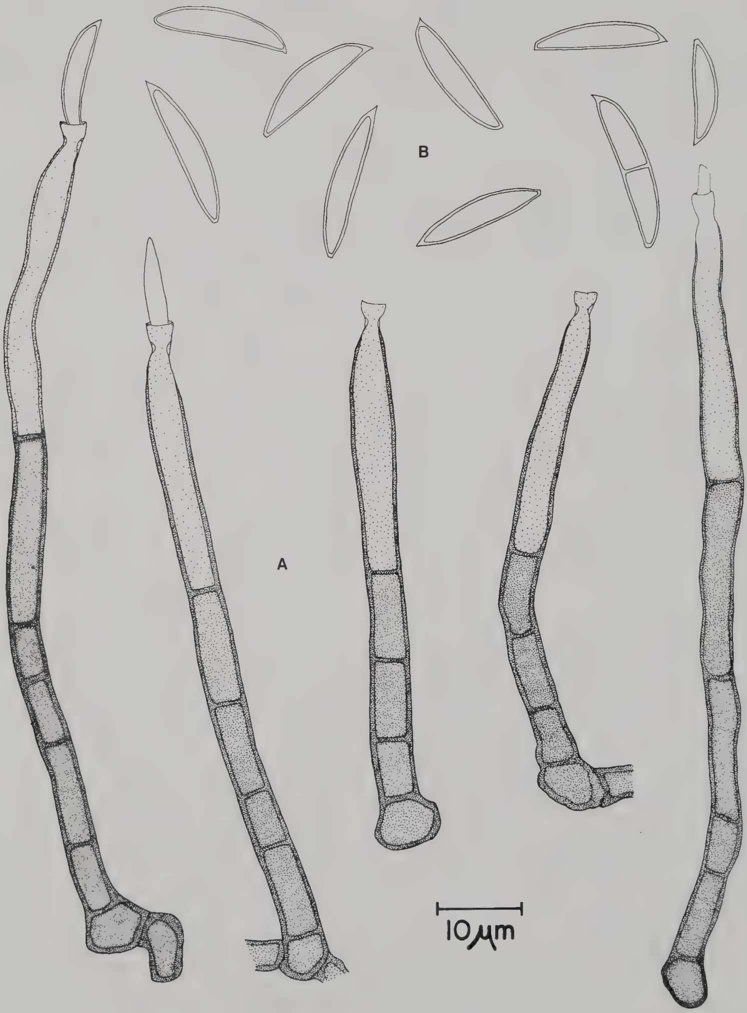

Fig. 1. Codinaea illinoensis, A. Conidiophores; B. Mature Conidia.

mononematous, simple, straight or slightly curved, septate, hyaline to light brown, thick-walled, smooth, arising singly from the hyphae or nodulose cells. Conidiogenous cells monophialidic, integrated, terminal, slightly lageniform, thin-walled at apex, thick-walled at base, 30-37 x 5.6-6.7 μm. Collarettes conspicuous, funnel-shaped, flaring, distally thin-walled, thick-walled and refringent at base, 2.3-3.3 x 3.3-4.4 μm. Phialoconidia hyaline, unicellular or occasionally 1-septate, slightly curved, symmetrical, tapering to a bluntly rounded distal end bearing a rudimentary apiculate setula, basal end tapering with a blunt scar.

Holotype: On decayed wood, cypress swamp, N.W. of Vienna, Johnson County, Illinois, 9 July 1969, J.L. Crane 98-69, ILLS 42169.

Codinaea lunulospora Hewings & Crane sp. nov. Fig.2, A-F

Coloniae effusae, pallide demum obscure brunneae. Mycelium in substrato immersum, e hyphis crasse tunicatis, ramosis, septatis, subhyalinis vel pallide brunneis compositum. Setae nullae. Conidiophori e basibus sculptis orti, macronemati, mononemati, simplices, recti, septati, obscure brunnei, crasse tunicati, leves, ad phialidis basim paulum attenuati. Cellulae conidiogenae phialidicae, integratae, terminales, lageniformes, ad apicem tenuiter tunicatae, hyalinae, crasse tunicatae, subhyalinae vel pallido brunneae ad basim. Collarula conspicua, infudibuliformis vel aliquantulum cylindrica, apicem versus tenuiter tunicata, sympodialiter semel vel bis instaurata, 3.6-4.5 x 1.8-2.7 μm, prope basim ad 1.4-1.8 μm attenuata. Phialoconidia hyalina, continua, lunata vel sigmoidea, symmetrica, 8.8-12.0 x 0.8-1.0 μm. Holotypus: Dumont-VE 4619 (NY). Isotypus: (VEN).

Colonies effuse, light brown becoming dark brown. Mycelium immersed in the substrate, composed of thick-walled, branched, septate, subhyaline to light brown hyphae. Setae absent. Conidiophores arising from sculptured bases, macronematous, mononematous, simple, straight, septate, dark brown, thick-walled, smooth, tapered slightly at base of phialide. Conidiogenous cells phialidic, integrated, terminal, lageniform, thin-walled and hyaline at apex, thick-walled, subhyaline or light brown at base. Collarettes conspicuous, funnel-shaped to somewhat cylindrical, distally thin-walled, developing sympodially with 1-2 successive proliferations, 3.6-4.5 x

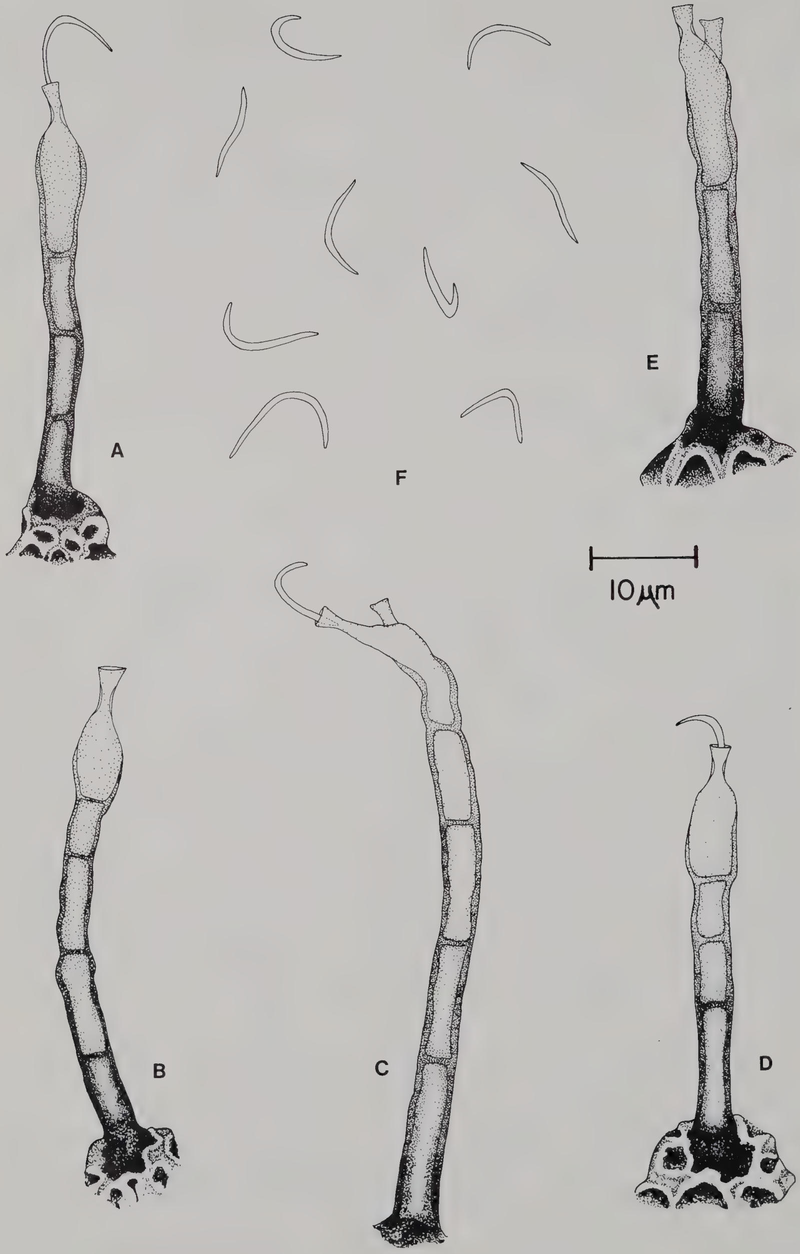
A
F
E
10µm
B
C
D

Fig. 2. Codinaea lunulospora, A-E. Conidiophores; F. Mature Conidia.

1.8-2.7 µm narrowing to 1.4-1.8 µm at base. Phialoconidia hyaline, unicellular, crescent-shaped or sigmoid, symmetrical, 8.8-12.0 x 0.8-1.0 µm.

Holotype: On unidentified herbaceous stem. Trail between Manacal and Los Pocitos, N.W. of Irapa, Edo Sucre, Venezuela, 10 July 1972. K.P. Dumont *et al.*, Dumont VE-4619 (NY), Isotype: (VEN).

Codinaea matsushimae Hewings & Crane sp. nov. Fig. 3, A-D

Coloniae effusae, pallide brunneae, demum obscure brunneae. Mycelium in substrato immersum, e hyphis crasse tunicatis, ramosis, septatis, subhyalinis vel pallide brunneis compositum. Setae singillatim vel gregatim ortae, rectae, crasse tunicatae, leves, ad vicies septatae, ad basim obscure brunneae, ad apicem obtuse rotundatum pallide brunneae vel subhyalinae, usque 340 µm longae, e basi 6.7 µm lata ad apicem 4.4 µm lata attenuatae. Conidiophori e cellularum nodo setarum socio orti, macronemati, mononemati, simplices, recti vel paulum arcuati, septati, hyalini vel pallide brunnei, crasse tunicate, leves. Cellulae conidiogenae phialidicae, integratae, terminales, hyalinae, paulum lageniformes, ad apicem tenuiter, ad basim crasse tunicatae, 14-27 x 3.0-6.0 µm. Collarula conspicua, evanescens, ad marginem tenuiter, ad basim abrupte crasse tunicata, synpodialis, semel, bis, vel ter instaurata, 2.0-3.0 x 2.0-4.0 µm. Phialoconidia setulis ornata, hyalina, ter ver raro semel vel bis septata, paulum arcuata, symmetrica, ad apicem obtuse rotundatum et basim cicatrice notatum attenuata, 20-27 x 3.3-5.4 µm. Setulae alia ad apicem, alia juxtam cicatricem basalem affixae, 5.5-7.8 µm longa. Typus: ILLS 42170.

Colonies effuse, light brown becoming dark brown. Mycelium immersed in the substrate, composed of thick-walled, branched, septate, subhyaline to light brown hyphae. Setae arising singly or in groups, erect, thick-walled, smooth, up to 20-septate, dark brown at base, pale brown to subhyaline at bluntly rounded apex, up to 340 µm long, tapering from 6.7 µm wide at base to 4.4 µm at apex. Conidiophores arising singly from a knob of cells associated with setae, macronematous, mononematous, simple, straight to slightly curved, septate, hyaline to light brown, thick-walled, smooth. Conidiogenous cells phialidic, integrated, terminal, hyaline, slightly lageniform thin-walled at apex, thick-walled at base, 14-27 x 3.0-6.0 µm. Collarettes conspicuous becoming evanescent,

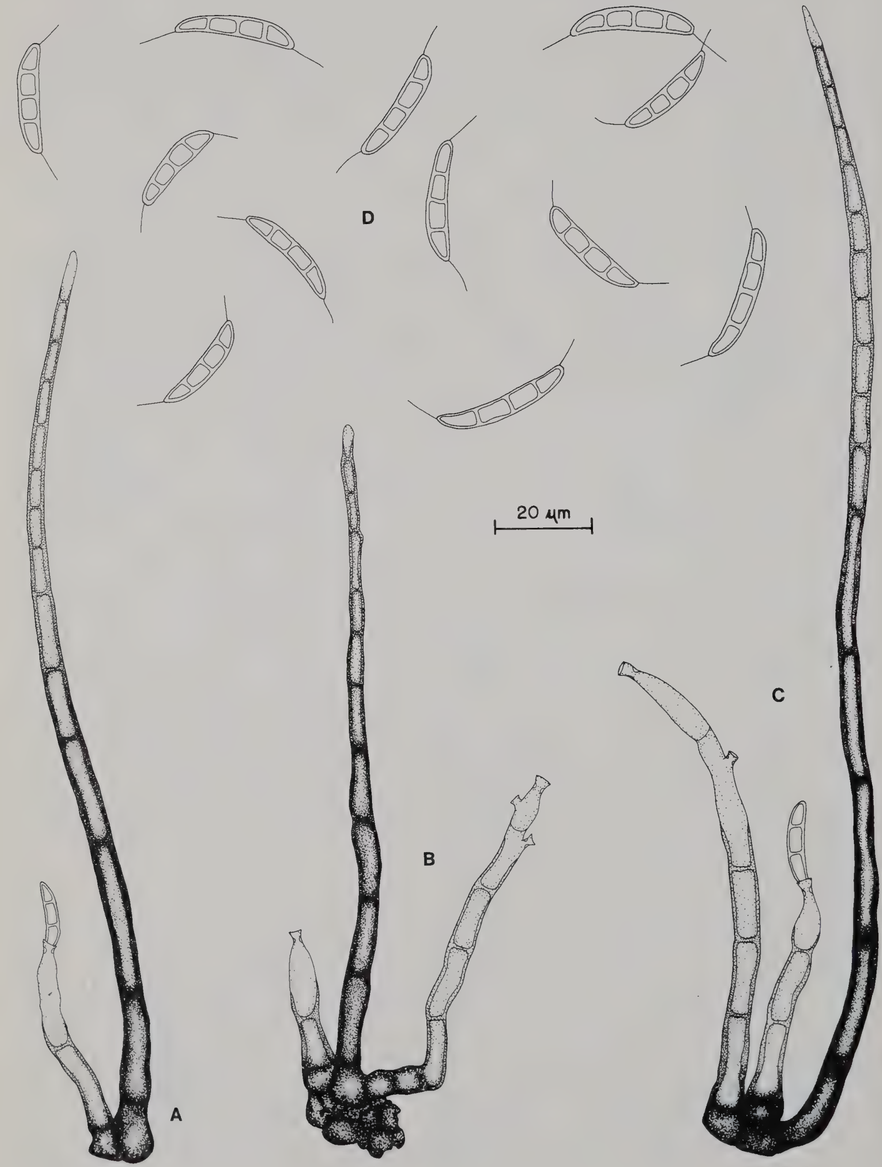

Fig. 3. Codinaea matsushimae, A–C. Conidiophores and setae; D. Mature Conidia.

distally thin-walled, abruptly thick-walled at base, sympodial with 1-3 proliferations, 2.0-3.0 x 2.0-4.0 µm. Phialoconidia with setulae, hyaline, 3-rarely 1 or 2-septate, slightly curved, symmetrical, tapering to a bluntly rounded distal end and a proximal basal scar, 20-27 x 3.3-5.4 µm. Setulae attached at distal end and to one side of basal scar, 5.5-7.8 µm long.

Type: On exocarp of *Carya*, Benson´s Bluff, S.E. of Gorevill, Johnson County, Illinois, 4 April 1969, J.L. Crane 12-1-69, ILLS 42170. Other Material Examined: On decayed wood, Elvira Cypress Swamp (Deer Pond), Johnson County Illinois, 22 May 1969, J.L. Crane, 91-69, ILLS 42171.

Key to the Species of *Codinaea* Maire*

1. Conidiophores synnematous .... *C. obesispora* (3)
Conidiophores monenematous 2
2. Phialoconidia with setulae 3
Phialoconidia without setulae 22
3. Phialoconidia with a setula at each end 6
Phialoconidia with 1 apical setula 4
4. Setula definite, 13-15 µm long ..... *C. unisetula* (7)
Setula apiculate 5
5. Phialoconidia 14-19 x 3.3-4.4 µm . *C. illinoensis*
Phialoconidia 20-30 x 4.0-5.5 µm ... *C. apiculata* (6)
6. Phialoconidia septate 7
Phialoconidia non-septate 12
7. Setulae < 3.0 µm long .... *C. brevisetula* (3)
Setulae > 3.0 µm long 8
8. Phialoconidia 3-septate .... *C. matsushimae*
Phialoconidia 1-septate 9
9. Setae present 10
Setae absent 11
10. Setae simple or branched, sterile or fertile;
conidia 14-17 x 1.8-2.7 µm ....
Chaetosphaeria dengleyae anam. *Codinaea* (3)
Setae simple, apex fertile;
conidia 13-20 x 2.5-3.5 µm *C. novae-quineensis* (5)
11. Conidiophores 1-3-septate; conidiogenous cells
usually terminal .... *C. septata* (11)
Conidiophores up to 20 septate; conidiogenous
cells usually intercalary .... *C. eucalypti* (11)

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*Numbers in parentheses refer to literature cited.

12. Setae present 13
Setae absent 19
13. Setae fertile 14
Setae sterile 17
14. Phialides from node-like hyphae
on setae .... *C. gonytrichodes* (10)
Phialides from base of setae 15
15. Setae < 250 µm long .... *C. pakhalensis* (9)
Setae > 250 µm long 16
16. Setae slightly geniculate at apex ... *C. fertilis* (3)
Setae straight, cylindrical to gradually
tapering at apex .... *C. assamica* (3)
17. Setulae of unequal length .... *C. aristata* (4)
Setulae equal in length 18
18. Setulae 5-9 µm long .... *C. britannica* (1)
Setulae up to 1.0 µm long ....
Chaetosphaeria pulchriseta anam. *Codinaea* (3)
19. Setulae < 6 µm long 20
Setulae > 6 µm long 21
20. Phialoconidia 11-17 µm long .... *C. parva* (3)
Phialoconidia 17-23 µm long .... *C. vulgaris* (3)
21. Phialoconidia with acute apex,
23-28 µm long .... *C. longispora* (3)
Phialoconidia with bluntly pointed apex,
14-19 µm long .... *C. simplex* (3)
22. Phialoconidia septate 23
Phialoconidia non-septate 26
23. Phialoconidia 3-septate .... *C. apicalis* (3)
Phialoconidia 1-septate 24
24. Conidiophores branched
and ornamented .... *C. glauco-nigra* (3)
Conidiophores simple and smooth 25
25. Phialoconidia 10-16 x 2.5-3.5 µm ...... *C. lunata* (6)
Phialoconidia 20-24 x 2.0-2.8 µm ...... *C. setosa* (3)
26. Conidiophores branched 27
Conidiophores simple 28
27. Phialoconidia 20-26 µm long .... *C. hughesii* (1)
Phialoconidia 10-15 µm long ....
Chaetosphaeria callimorpha anam. *Codinaea* (3)
28. Phialoconidia strongly curved 29
Phialoconidia straight or slighly curved 30
29. Phialoconidia sigmoid .... *C. lunulospora*
Phialoconidia botuliform .... *C. botulispora* (3)
30. Phialoconidia cylindrical ...... *C. cylindrospora* (7)
Phialoconidia tapering towards base 31
31. Phialoconidia abruptly tapered
at base .... *C. clavulata* (2)
Phialoconidia gradually tapered at base ....
Chaetosphaeria talbotii anam. *Codinaea* (3)

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A NEW SPECIES OF DACRYOPINAX FROM BRAZIL

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Dacryopinax maxidorii Lowy, sp. nov.

Fructificatio in humido aurantiolutea, elastico-gelatinosa, pileata, 4.5 cm alta ad 5 cm lata; sicca cornea, ferrugineo-brunnea; caulis elongatus, firme radicatus, conspicuus, crassi-venatus; in sicco dense albido-tomentosus; apicis alte ramosus, deinde polycephalus, lobuli flabelliforme ad 450 µm crassis cum margine crenulata; hymenio glabrum, unilaterali, inferiori, pauci pilosa; probasidia cylindraceae, aseptata, 30.0-36.5 X 4.5 µm, metabasidia furcata, aseptata, bisterigmata; hyphae enodosae, 2.0-3.0 µm diam; basidiosporae leviter curvulo-cylindraceae vel subovoideae, uniseptatae, in cumulo aurantiaco-lutea, (7.0-) 8.0-10.0 (11.5) X 4.5-5.0 µm, per promycelium aut conidia germinantes; conidia subspherica, 1.5-2.5 µm diam.

Fructification when fresh rubbery gelatinous, orange-yellow, stipitate, pileate, up to 4.5 cm in height, 5 cm broad (Fig. 1); drying horny, rusty brown; arising from a broad, elongated, firmly rooted, sterile stalk; thick veined, densely whitish-pilose when dry, with pilosity diminishing upward; deeply branched apically, frequently becoming polycephalic with broad, veined, flabelliform lobes ± 450 µm thick, often with crenate margins; hymenium unilateral, inferior, producing a dense palisade of basidia; abhymenium thinly covered with hyaline, cylindrical to slightly inflated, unbranched hairs, unicellular to sparsely septate, arising from a layer of irregularly inflated hyphae; probasidia cylindrical, unicellular, 30.0-36.5 X 4.0-4.5 µm; occasional cylindrical, slender, unbranched dikaryophyses 20-25 X 2.5-3.0 µm; metabasidia furcate, bisterigmate; hyphae without clamp connections, 2.0-3.0 μm diam; basidiospores slightly curved-cylindrical to subovoid with narrowed apices and prominent apiculus, with a single, thick, central septum, (7.0-) 8.0-10.0 (-11.5) X 4.5-5.0 μm, producing subspherical conidia 1.5-2.5 μm diam, or germinanting by germ tube.

Holotype. Brazil. Lowy 190 BR (TYPE), km 405 Manaus-
Porto Velho road, Amazonas, 16-IX-1980.
Leg. B. Lowy, D. Coelho. On unidentified log.

This species is named for Maxine and Doris Lowy, enthusiastic collectors of tremellaceous fungi.

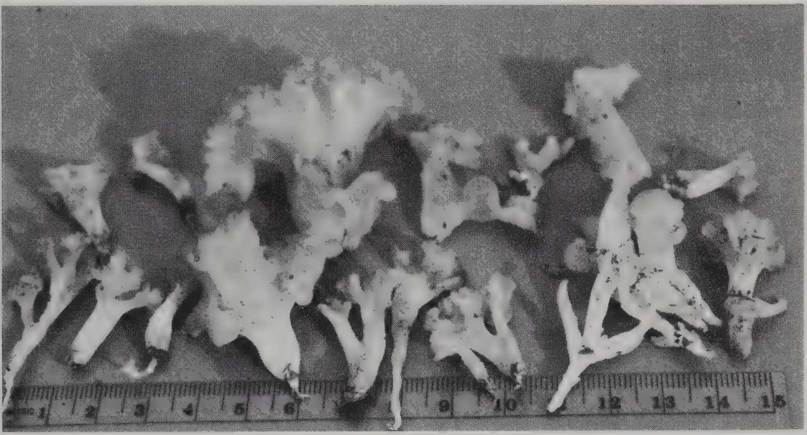

Figure 1. Basidiocarps of *Dacryopinax maxidorii* with scale shown in millimeters.

In gross morphology the new species somewhat resembles *D. indacocheae* Lowy (1959), except for the latter's stubby stalk, thinner lobes, and brownish to earth-colored pigmentation. However, the long stalk, bright carotinoid pigmentation, and flabelliform lobes of the new species places it closer to *D. martinii* Lowy (1971). The basidiospores of these three species are predominantly 1-septate, but *D. maxidorii* shares with *D. indacocheae* somewhat curved-cylindrical spores with a single, thick septum whereas the spores of *D. martinii* are characteristically thin septate.

The following revised key includes the seven known species of Dacryopinax occurring in tropical America.

1. Basidiocarp slightly expanded apically; pileus simple or branched. 2

    2. Stipe tomentose; basidiospores becoming 1-septate. . . . . D. spathularia
    2. Stipe not tomentose; basidiospores becoming 3-septate. . . . . D. dennisii

1. Basidiocarp broadly expanded apically; pileus grossly lobed to flabelliform or polycephalic 3

    3. Long stipitate; pileus flabelliform. 4
    3. Short stipitate to substipitate; pileus not flabelliform. 5

    4. Abhymenium and stipe smooth; dried pileus thin, fragile. . . . . D. martinii
    4. Abhymenium and stipe pilose; dried pileus thick, robust. . . . . D. maxidorii

    5. Hymenium coarsely papillate, yellow when fresh. . . . . D. yungensis
    5. Hymenium smooth, not yellow when fresh . . . 6

    6. Pileus spreading-orbiculate, undivided, drying dark brown to blackish. . . . . D. elegans
    6. Pileus foliose, deeply lobed, drying light brown. . . . . D. indacocheae

ACKNOWLEDGEMENTS

Thanks are due The New York Botanical Garden, the Instituto Nacional de Pesquisas da Amazonia (Manaus, Amazonas, Brasil), and Louisiana State University (Baton Rouge, LA), under whose sponsorship the field work was completed as part of the Projecto Flora Amazonica.

LITERATURE CITED

Lowy, B. 1959. New or Noteworthy Tremellales from Bolivia. Mycologia 51: 840-850.

_______. 1971. Tremellales. Flora Neotropica. Monograph 6, Hafner Publishing Company, Inc. New York.

MYCOTAXON

Vol. XIII, No. 2, p. 431 July-September 1981

NOTICE

THIRD INTERNATIONAL MYCOLOGICAL CONGRESS

IMC_3 will be held in Tokyo, Japan, from 28 August till 3 September, 1983. Several affiliated organizations have indicated they wish to be involved in the organization of the program, particularly with regard to symposia and the provision of time for business meetings they may wish to hold. Possible titles for symposia, with names and addresses of potential organizers, and details of any other suggested activities should be submitted as soon as possible to the Organizing Committee (Secretary General, Prof. K. Tubaki, Institute of Biological Sciences, University of Tsukuba, Sakura-mura, Ibaraki 300-31, Japan). A copy of any letter should be sent to the Secretary of the International Mycological Association, Dr. D. L. Hawksworth, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey TW9 3AF, England. Suggestions should be submitted as rapidly as possible.

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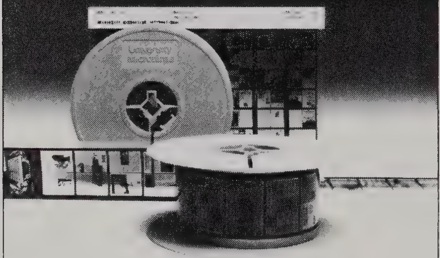

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MYCOTAXON

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STUDIES IN THE LICHEN GENUS PSOROMA I PSOROMA TENUE AND PSOROMA CINNAMOMEUM

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SUMMARY

The new species *Psoroma tenue* Henssen belongs to the *P. hypnorum*-group and is most closely related to *P. cinnamomeum*. Two varieties are described. *P. tenue* var. *tenue* is restricted to the Southern Hemisphere; the lichen has been collected in Tierra del Fuego and the South Shetland Islands. *P. tenue* var. *borealis* Henssen is a wide-spread northern taxon; localities are given for the Alps, Scandinavia, Iceland and North America. *P. tenue* is a species of snowbanks, glacial till and tundral heath. The lichen contains porphyrilic acid methyl ester and pannaric acid. The occurrence of these metabolites in other members of the *P. hypnorum*-group is mentioned. A short description of anatomical structures in *P. cinnamomeum* is included.

INTRODUCTION

The lichen genus *Psoroma* Michx, a member of the Pannariaceae, occurs predominantly in the Southern Hemisphere, in South America and New Zealand. The type species *P. hypnorum* (Vahl) S.F. Gray (Synonyms: *P. bryantii* Dodge as *"Bryanti"* in Trans. Amer. Microscop. Soc. 84:511, 1965, holotype: hb. Dodge; and *P. follmannii* Dodge in Trans. Amer. Microscop. Soc. 84:510, 1965, isotype: KASSEL) only is known to be world wide distributed.

Our studies in *Psoroma* are mainly restricted to South American species, based on collections made by A. Henssen and G. Vobis in southern Chile and Argentina in 1973 / 74. P.W. James who was planning a monographic treatment of the genus encouraged us to collect *Psoroma* species intensively. The series of *Psoroma* papers, published in part together with P.W. James and K. Marton, may be regarded as preliminary studies for a world monograph. In this initial paper, A. Henssen is responsible for the taxonomic treatment; and B. Renner, for the identification of the lichen substances.

In its current circumscription *Psoroma* is a heterogenous genus, and affinities of certain species to *Pannaria* Del. in Bory have been suggested (James & Henssen 1976, Jørgensen 1978). The species of the *P. hypnorum*-group, for example, form a distinct assemblage of terricolous lichens of cold temperature or subalpine / alpine areas. They may be more closely related to *Pannaria pezizoides* (G.H. Web.) Trevis. than to the corticolous / saxicolous, squamulose or lobate species of *Psoroma* with which they are at present allied (James & Henssen 1976).

The new species *P. tenue* belongs to the *P. hypnorum*-group. The outstanding character of the species is a pattern of lichen substances not previously known to occur in *Psoroma* s.l. The specimens of *P. tenue* so far studied always contain pannaric acid and the new compound porphyrilic acid methyl ester and some specimens contain an unknown substance (U_1) (Renner et al. 1981). Specimens from the Northern Hemisphere differ slightly in morphology from the southern hemispheric ones and are included in the variety *borealis*.

In *P. hypnorum*, no lichen substances were found by TLC (Jørgensen 1978). We confirmed this observation in the type specimen (C) and in the types of the synonymous species *P. bryantii* (hb. Dodge) and *P. follmannii* (KASSEL) as well as in a number of our specimens from northern and southern localities. All of these specimens were similar with regards to external and internal morphology. However, certain specimens, deviating to some extent in morphology, were found to contain one, two or all three of the compounds described from *P. tenue*. These specimens need further taxonomic investigation. Porphyrilic acid methyl ester and pannaric acid also occur in the new *P. rubromarginatum* P. James & Murray (Henssen et al. in manuscript), and the unknown (U_1) occurs in a South American specimen of *P. paleaceum* (Fr.) Nyl. (? P. hirsutulum Nyl.) (Henssen 24353g: MB).

Within the *P. hypnorum*-group, several patterns in thallus anatomy may be recognized. *P. tenue* corresponds to *P. cinnamomeum* in external and internal morphology of the thallus and cephalodia. The two species, therefore, are regarded to be closely related. Although the South American species *P. cinnamomeum* was well - described by Malme (1952), additional information obtained by modern methods is included in the presented paper.

MATERIAL AND METHODS

MATERIAL. The abbreviations of herbaria follows those given in *Index Herbariorum*; hb. Dodge means the private herbarium of C. Dodge, Burlington, Vermont, U.S.A., and hb. Henssen means the private herbarium of the senior author.

Psoroma cinnamomeum: Argentina, Tierra del Fuego, Rio Grande, 1896, Dusén 115 (holotype: S); Cabo San Pablo, on plant debris in a tundra heath, overgrowing a dead liverwort, 1973, Henssen & Vobis 24448t (MB). *P. hypnorum* (selected specimens): Norway, Vahl (lectotype by Jørgensen: (C). Sogn og Fjordane, Nordfjordeid, on rock overgrowing mosses, 1959, Henssen 5339 (hb. Henssen). - Finland, Lapponia enontekiensis, Toskaljärvi, 1955, Henssen 6145 (hb. Henssen). - Argentina, Tierra del Fuego, Glaciar Martial, on rock overgrowing mosses, 400m s.m., 1973, Henssen & Vobis 24412a (MB); Laguna Escondida, Henssen & Vobis 24439h and 24460d (MB). - Antarctic Peninsula, Refuge Island, 1940, Bryant 30-2 (holotype of *P. bryantii*: hb. Dodge). - South Shetland Islands, Greenwich Island, Bahia Soberanía, on mosses, 1963, Follmann 11843 (isotype:

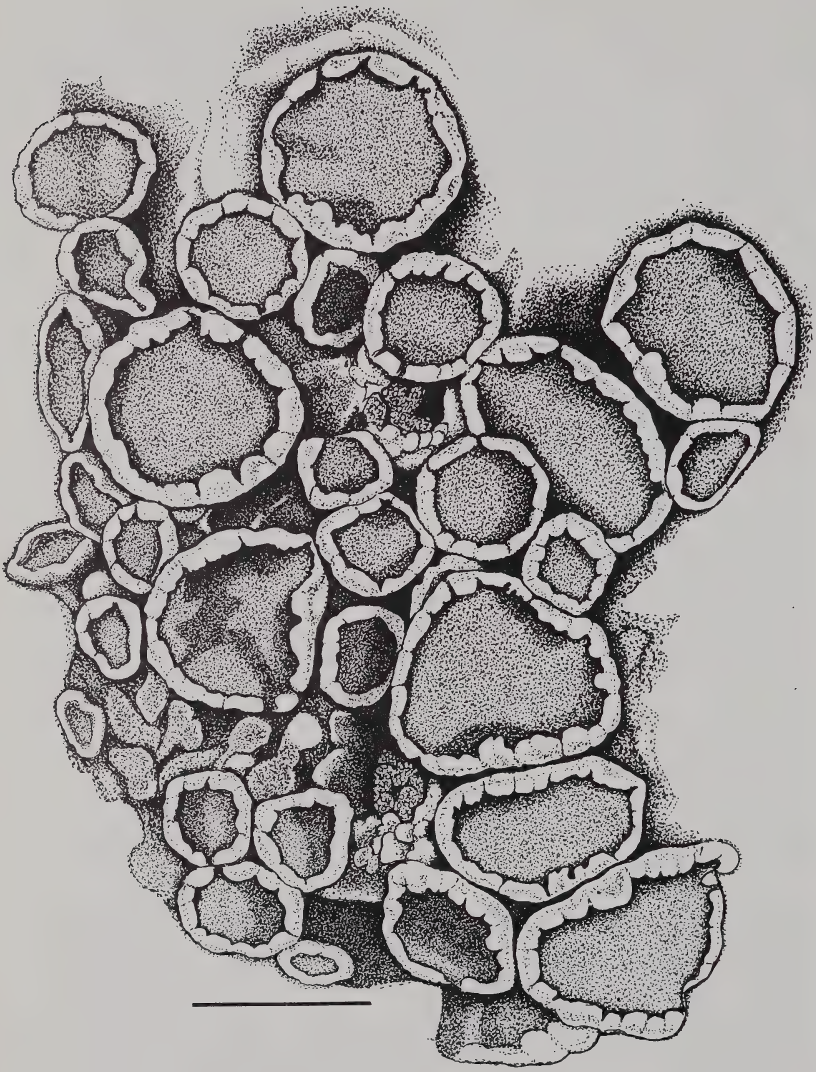


Fig. 1. *Psoroma tenue* var. *tenue* (paratype), young and mature densely aggregated apothecia; scale = 1 mm; drawn by H. Becker.

of *P. follmannii*: KASSEL). *P. paleaceum*: Argentina, Tierra del Fuego, between Ushuaia and Lapataia, on rock overgrowing mosses, 1973, Henssen & Vobis 24353g (MB). *P. tenue*: see below.

MORPHOLOGY. Samples were sectioned by freezing microtome and the sections mounted in lactophenol cotton - blue. Measurements of spores and anatomical structures were made from permanent preparations; measurements of gross morphology on air - dried specimens. For studying the ascus structure, KI_3 solution was added directly to the squash preparation.

CHEMISTRY. Crude lichen extracts were chromatographed in solvent systems A, B, C of Culberson (1972), and D, E of Renner (1980). The methods of mass spectrometry and UV/VIS spectroscopy were used for the identification of the lichen substances; details are given in Renner et al. (1981).

TAXONOMIC PART

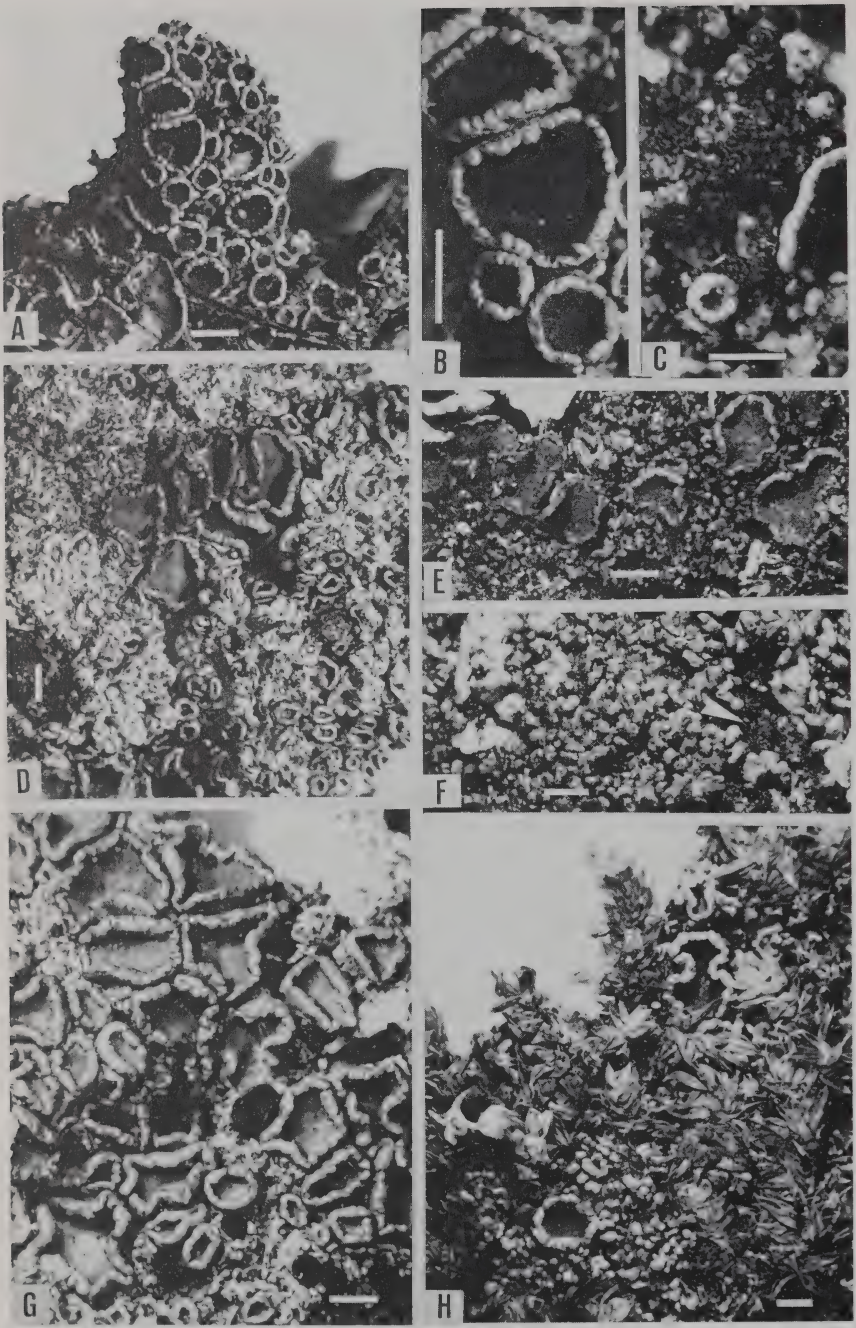
Psoroma tenue Henssen, sp. nov. var. *tenue*

Habit, Fig. 1, 2A-C; thallus anatomy, Fig. 3A-C, structure of the ascocarp, Fig. 4A-D.

DIAGNOSIS. Thallus granulatus vel subsquamulosus, pallidus vel fuscescens, e verrucis formatus semiglobosis, circiter 0.2 - 0.4 mm latis vel e squamulis plus minusve adscentibus, 0.4 - 0.8 mm latis, crassis, dispersis vel subcontiguis. Thallus corticatus, hyphae medullosae reticulum formantes, alga symbiotica laete viridis, ad familiam Chlorococcaceae pertinens. Cephalodia globularia vel ramosa, plus minusve aggregata, atropurpurea, corticata, alga ad *Nostoc* pertinens.

Apothecia usque ad 2 (-3)mm lata, disco plano vel subplano, atrofusco, margo thallinus vulgo pallidus, tenuis, subtiliter crenulatus. Hymenium 95-120 (-150)µm altum. Asci subcylindrici, 80-110 x 8-12µm, 8-spori, annulo amyloidea in apice asci incrassato, Sporae eseptatae, incolores, polymorphae, ovoideae vel subfusiformes, 19-24 x (5-)7-10 (-12)µm, superfice verruculosa. Pycnidia minuta, circiter 0.1-0.16 mm lata, conidiophora brevicellularia, conidia terminalia et lateralia formantia. Conidia baciliformia, circiter 2-4 x 1 µm.

Chemistry: thallus and apothecia contain porphyrilic acid methyl ester, pannaric acid, in the holotype the unknown substance (U_1) was found.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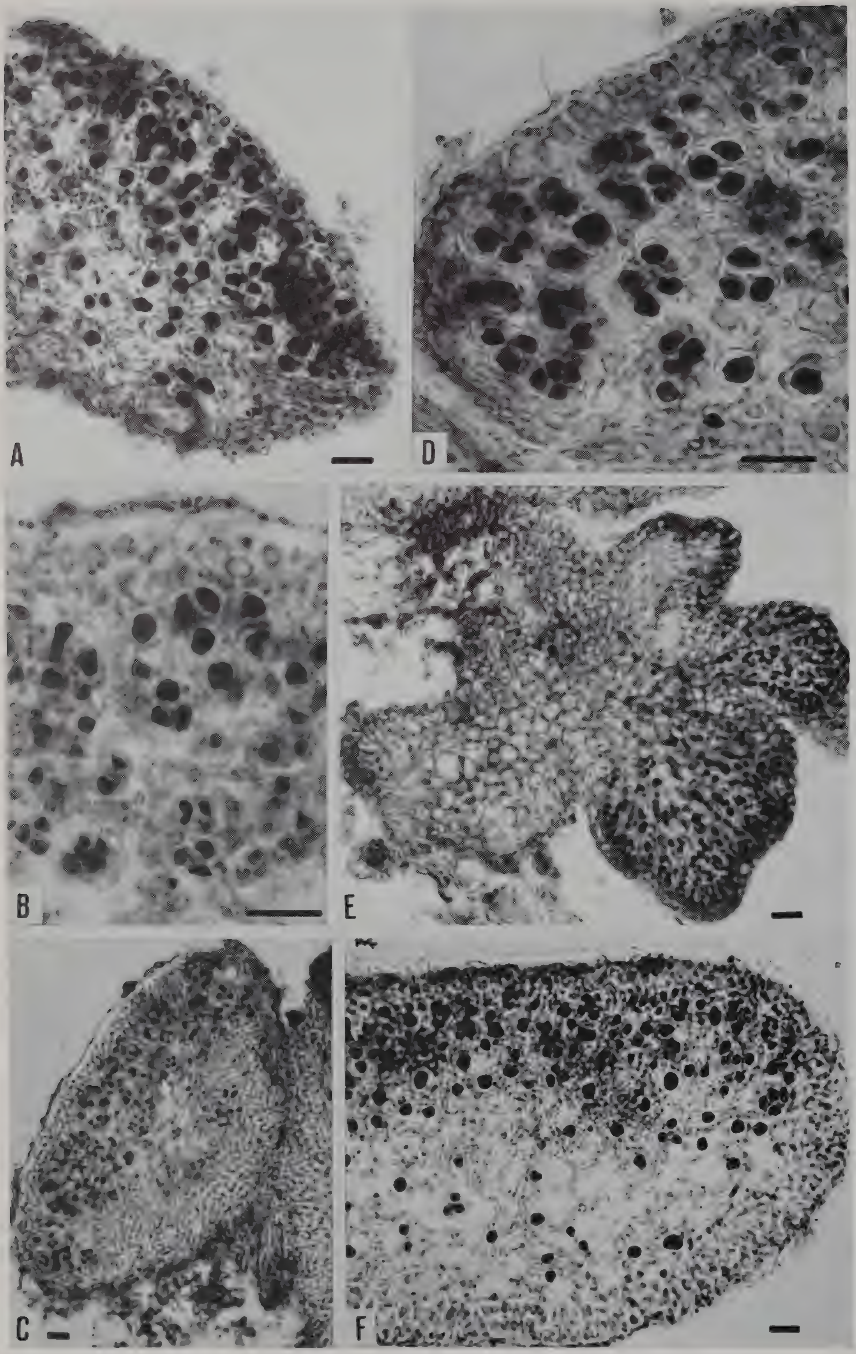
Holotype: Argentina, Tierra del Fuego, Parque Nacional de la Tierra del Fuego, Laguna Escondida, on loamy soil near the lake shore overgrowing *Cephaloziella* and plant debris, at c. 270m s. m. 1973 Henssen & Vobis 24439b (MB); isotypes: BM, LPS. Paratype: near the type locality at Hosteria Petrel, on soil overgrowing plant debris in a stand of *Nothofagus* at the lake shore, 1973 Henssen & Vobis 24460w (MB).

FURTHER SPECIMEN EXAMINED: South Shetland Islands, Greenwich Island, on earth and plant debris, 1963, Follmann 14065 (KASSEL).

Thallus of pale or more rarely brown colour, dull, composed of dispersed or aggregated minute granules and squamules, fastened by rhizoidal hyphae with colourless or brown thick walls. Granules up to 0.4 mm, squamules 0.4 - 0.8 mm broad, more or less ascending. Thallus sections (155-) 150-250 (450)µm high, at least on the upper surface distinctly corticated. Upper cortex in young thalli composed by thin-walled cells (Fig. 3A), later on the walls gelatinizing, and the lumina in the gelatinous matrix up to 18µm broad, connected by pits (Fig. 3B). Lower cortex composed of isodiametric or elongated cells (Fig. 3C). Medullary hyphae (2.5-)4-6µm thick, orientated reticulately and enclosing single or several algal cells. Phycobiont a member of the Chlorococcaceae, cells c.6-10µm broad, distributed throughout the thallus but more numerous in the upper part. Crystals of lichen substances deposited in clusters in the medulla.

Fig. 2. Habit photographs of *Psoroma* species. A-B, *P. tenue* var. *tenue* (paratype); A, lichen overgrowing plant debris; B, enlarged apothecia. C, *P. tenue* var. *tenue* (holotype); dark colored, aggregated cephalodia between thallus squamules and apothecia. D, *P. cinnamomeum* (holotype). E-F, *P. tenue* var. *borealis* (holotype); E, mature apothecia; F, cephalodia (arrowed) between squamules. G, *P. cinnamomeum* (holotype), crowded apothecia surrounded by a thick thalline margin; the black apothecia belong to a *Badicia* species. H, *P. tenue* var. *borealis* (hb. Henssen 6130), squamules and apothecia. A-H, scale = 1 mm.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Cephalodia granulary or coralloidly branched, dark purplish brown, singly or forming clusters up to 0.8 mm (Fig. 2C). Cephalodia corticated, cortex 4.5-12µm thick, formed by 1 to 2 rows of cells; medullary hyphae orientated in a network in young stages, later forming pseudoparenchyma (Fig. 5E). Alga a *Nostoc* species.

Apothecia dispersed or closely aggregated, up to 2(-3) mm broad, disc flat, dark brown, surrounded by a pale, finely crenulated margin (Fig. 1, 2A, B). Hymenium 95-120 (-150)µm high; hypothecium - layer including the ascogenous hyphae - 20-25(-50)µm; subhymenial layer of varying thickness, frequently extending into a stipe of adglutinated hyphae with enlarged cells towards the base. Margo thallinus corticated, basal part 100-120µm broad, composed of radiating hyphae with broad, up to 25µm wide cells; joint walls between the cell lumina 3.5-6µm thick (Fig. 4A, B). Crystals of lichen substances in clusters in the medulla of the margo thallinus.

Pycnidia inconspicuous, in sections 0.1-0.16 mm large. Conidiophores branched and anastomosing, conidiogenous cells short, the conidia terminally and laterally produced. Conidia rod-shaped, c.2-4 x 1µm.

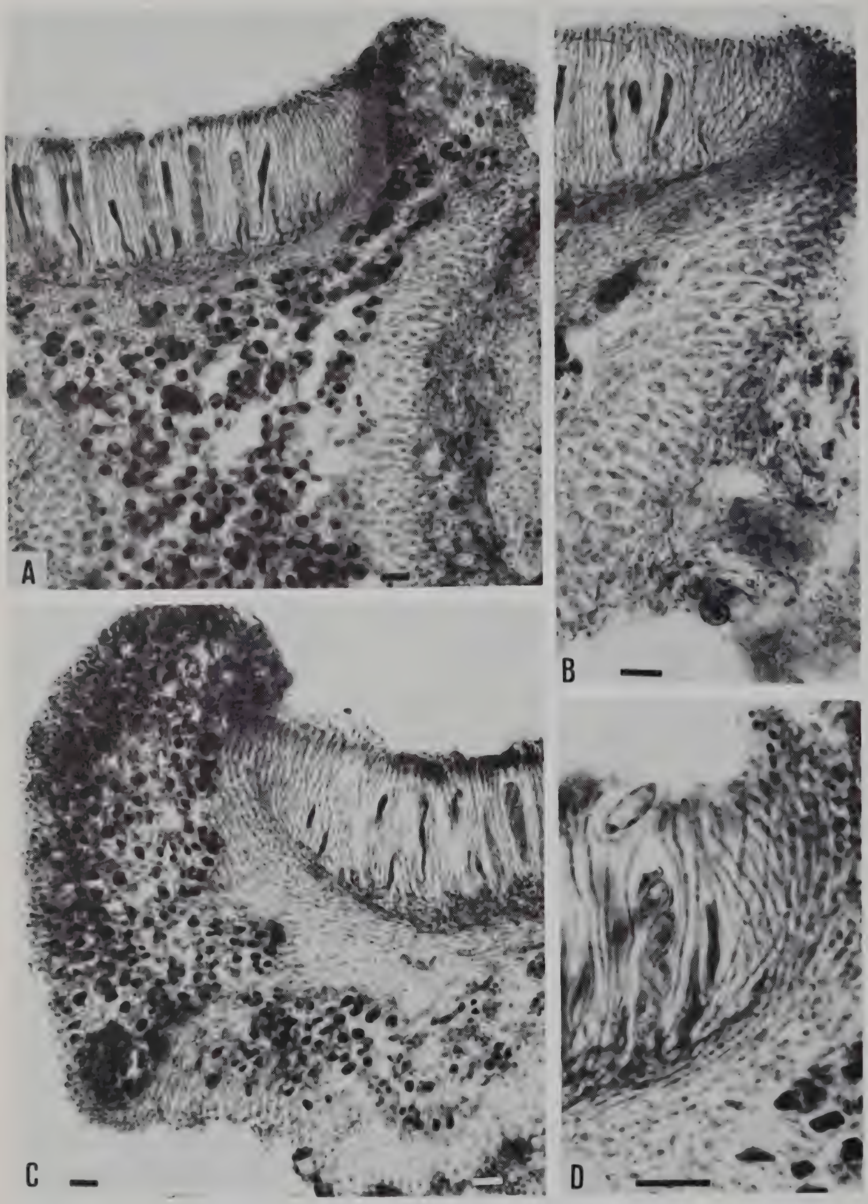
Psoroma tenue var. *borealis* Henssen var. nov.

Habit, Fig. 2E, F, H; thallus anatomy, Fig. 3D-F; structure of apothecium, Fig. 5C.

DIAGNOSIS. Differt a var. *tenue* thallo majori semper distincte corticato et colore cinnamomeo vel luteofusco.

Chemistry: thallus and apothecia contain porphyrilic acid methyl ester and pannaric acid, in the holotype and in the specimens from Austria, Ost-Tirol and Canada the unknown substance (U_1) was found.

Fig. 3. Thallus anatomy of *Psoroma* species (microtome sections). A-C, *P. tenue* var. *tenue* (holotype); A, l.s. of young thallus, crystals of lichen substances indicated by arrow; B, t.s. of upper cortex and algal zone; C, t.s. of thallus adjacent to an apothecium. D-E, *P. tenue* var. *borealis* (Henssen 22679g); D, l.s. of young thallus; E, l.s. of a cephalodium at the base of an apothecium. F, *P. tenue* var. *borealis* (Henssen 23157x), t.s. of corticated thallus. A-F, scale = 20 µm.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Holotype: U.S.A., Colorado, Boulder Co., Niwot Ridge, on snowbank, between 3300 and 3750 m, 1961, Henssen 13030b (hb. Henssen). Paratype: Austria, Tirol. Samnaungruppe, Zeblasjoch, on snowbank at 2450m, 1975, Henssen 22679g (MB).

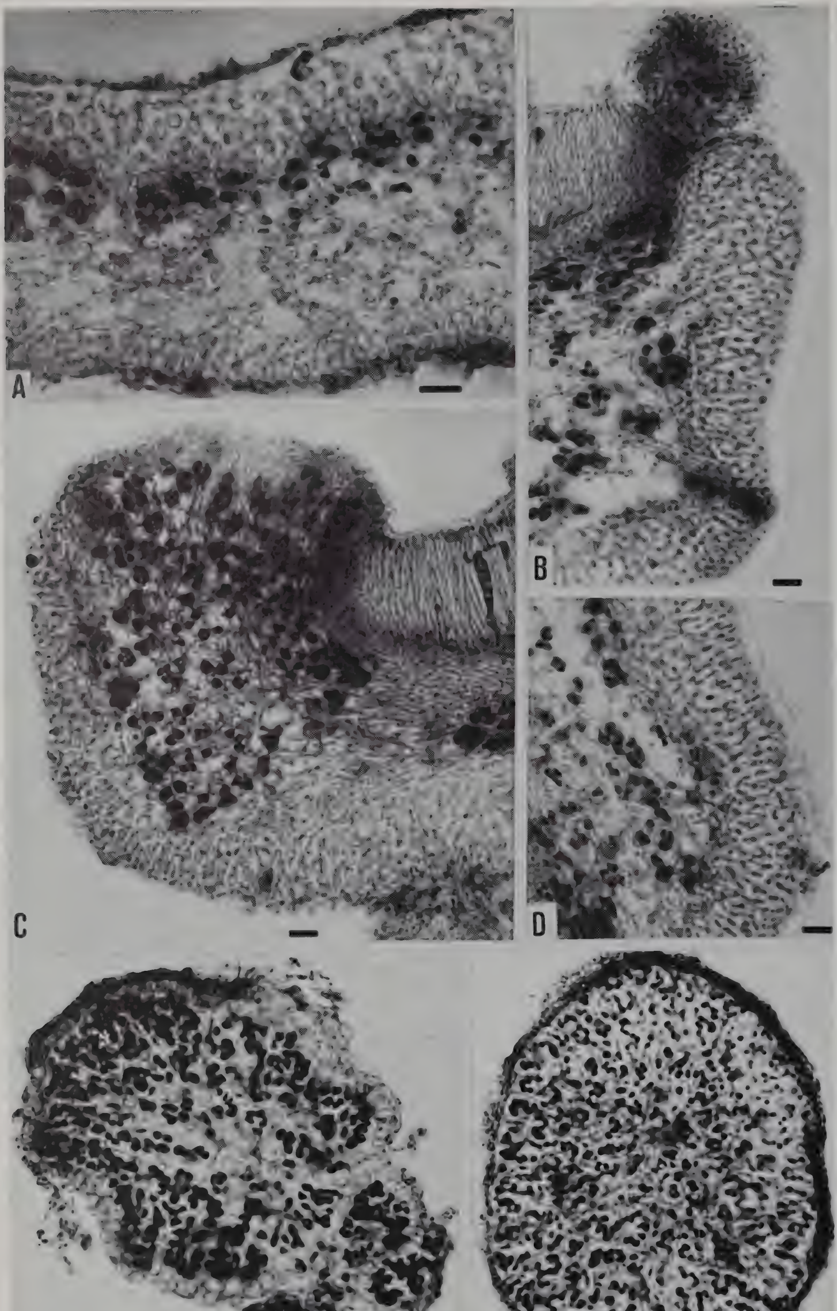
FURTHER SPECIMENS EXAMINED: Austria, Ost-Tirol, Matrei, Johannishütte, in glacial till at c. 2200 - 2400 m, overgrowing mosses, 1938 F. & Koppe (hb. Henssen 6130). - Norway, Sör-Tröndelag, Dovrefjell, Knuthö, on snowbank at 1500 m, 1959, Henssen 4974 (hb. Henssen). - Sweden. Torne Lappmark, Abisko. Nuolja, on snowbank at 1160 m, 1954, Henssen 6127 (hb. Henssen). - Iceland, Bard, Kollsvîk, overgrowing mosses in a lichen heath, 1972, Henssen & Kristinsson 23157x (MB). - Canada, Alberta, Banff National Park, Peyto Lake, *Dryas* heath at 2150-2250 m, 1962, Henssen & Cain 14471y (CAN, MB).

Thallus squamules up to 1 mm broad, brown or reddish brown, thick; thallus distinctly corticated on the upper and lower surface by isodiametric cells (Fig. 3D, F). Apothecial disc brown and margo thallinus of the same colour, or disc dark brown and margo thallinus slightly paler. Crystals of lichen substances deposited within the medulla of the thallus and apothecial margin or not.

In *P. tenue* var. *tenue* the lobes are smaller than in var. *borealis* (Fig. 2), and the cortex is usually less well developed since it is restricted to the upper surface. Broad cortical structures on both thallus surfaces have been observed in thalli closely attached to margins of apothecia (Fig. 3C). In such lobes the thallus corresponds exactly to that in *P. cinnamomeum* (cf. Figs. 3B with 5A).

The cephalodia occur either between the lobes or are producted in groups below the apothecia (Fig. 3E). The alga in the cephalodia is a

Fig. 4. Apothecial structure in *P. tenue* var. *tenue* (microtome sections of the holotype). A, median l.s. of young apothecium, note the numerous algal cells in the stipe; B, cortex structure in apothecial margin; C, upper part of apothecial margin, crystals of lichen substances indicated by arrows; D, ascus and spores. A-D, scale = 20 µm.


A
B
C
D
E
F

species of *Nostoc* as is found in most *Psoroma* species.

The margin of the apothecia develops in the same way as in *Pannaria rubiginosa* (Ach.) Bury (Henssen 1969, 1981). The cortex in the margo thallinus is differentiated in part by the thallus cortex and in part by the medullary hyphae growing up between the hymenium and the thallus cortex (Fig. 4A, B). The cells formed by the medullary hyphae are considerable smaller in size (Fig. 4C, 5C). As seen from above the finely crenulated margin surrounding the relatively flat disc resembles that of certain *Pannaria* species. In very old apothecia the margin may bear granules and the disc becomes folded or medianly depressed. Young developing apothecia are at first urceolate.

The ascus wall and hymenial gelatine stain blue in iodine, and an amyloid ring structure is seen in the ascus apex of the same shape as that found in *P. hypnorum* (Keuck 1977).

In *P. tenue* var. *tenue* yellowish to brownish crystals of lichen substances are usually deposited in large amounts in the medulla of the thallus and apothecial margin. In var. *borealis* similar crystals have only been observed in the specimen collected in Canada (Henssen 14471y). These crystals are difficult to demonstrate in the sections by black and white photography but are rather impressive in microscopic examination of stained permanent preparations. The varying occurence of the unknown substance (U_1) in both varieties of the species is interesting.

Fig. 5. Anatomy in *Psoroma* species (microtome sections). A-B, *P. cinnamomeum* (holotype); A, l.s. of thallus; B, cortex structure in apothecial margin; C, *P. tenue* var. *borealis* (Henssen 22670g), apothecial margin; D, *P. cinnamomeum* (Henssen 24448t), cortex structure in apothecial margin; E, *P. tenue* var. *tenue* (holotype), l.s. of cephalodium; F, *P. cinnamomeum* (Henssen 24448t), l.s. of cephalodium. A-F, scale = 20 µm.

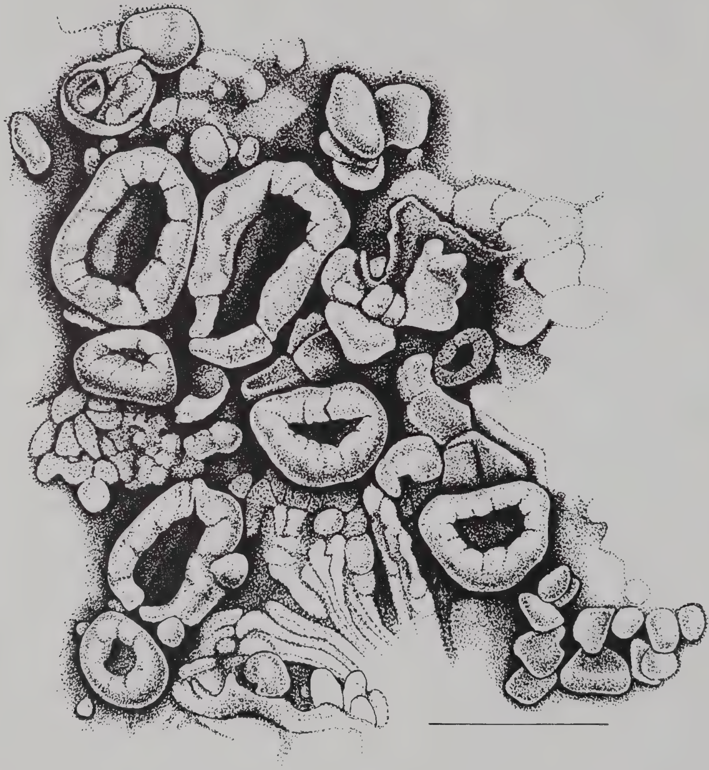


Fig. 6. *Psoroma cinnamomeum* (Henssen 24448t), young apothecia; scale = 1 mm; drawn by H. Becker.

Psoroma tenue is characterized by the presence of porphyrilic adic methyl ester and pannaric acid in correlation with small, flat apothecia surrounded by a thin evenly crenulated margin, by dark purplish brown cephalodia, aggregated to clusters, and by an upper thallus cortex formed by periclinal hyphae with isodiametric cells.

In comparison to *P. tenue*, *P. cinnamomeum* has a similar anatomy and the same type of cephalodia but differs, apart from the lack of lichen substances, by having a very thick apothecial margin in the young, strongly urceolate apothecia and by the smaller lumina in the cells forming the cortex in the margo thallinus (cf. Figs. 4C and 5C with B, D). *P. cinnamomeum* occurs in the same regions as *P. tenue* var. *tenue*. By the pale colour of the thallus and the abundant crystals in apothecial or thallus sections, *P. tenue* var. *tenue* is easily distinguished from *P. cinnamomeum*. Reddish brown specimens of *P. tenue* var. *borealis* resemble *P. cinnamomeum* but the variety is only known from the Northern Hemisphere at this time.

ECOLOGY. *P. tenue* var. *tenue* has been collected on soil, long covered by snow, together with *P. hypnorum* and *P. paleaceum*. *P. tenue* var. *borealis* has been found, hitherto, on snowbanks in glacial till and in tundral heath, where the lichen was growing together with *Leciophysma finmarkicum* Th.Fr. (23157x) or *L. furfurascens* (Nyl.) Gyeln. (14471y) respectively, among other lichens.

Psoroma cinnamomeum Malme 1925 P. 11, 12

The specimen studied in comparison to the holotype (Henssen 24448t) was growing on the same type of substrate. The prominent apothecial margin is especially distinct in younger apothecia (Fig. 1G, 6). The cortex was well developed in all sections studied. In the upper cortex the cell lumina are embedded in the gelatinous matrix of the cell walls. The lumina are roundish and connected by pits (Fig. 5A). In young thalli the cortex is formed only by periclinally arranged hyphae, later on cells are added by vertically growing medullary hyphae. In the lower thallus cortex the cell walls are less strongly gelatinized. The cortex in the margo thallinus is formed by radial or somewhat reticulately arranged hyphae with thick walls and relatively small lumina (Fig. 5B, D).

The cephalodia are dark purplish brown and form clusters between the squamules or they are produced in groups below the apothecia. They are surrounded by a brown pigmented cortex, composed of one or, in part, two rows of cells (Fig. 5F).

In young stages the hyphae are thin and form a network and later the enlarged cells become aggregated into a pseudoparenchyma.

ACKNOWLEDGEMENTS

These studies were supported by a grant of the Deutsche Forschungsgemeinschaft, which also provided a travel grant for the field studies in South America. In Tierra del Fuego we were guests at the Marine Biological Station in Ushuaia, and the excursions were guided by Dr. S. Guarrera from the University of La Plata. We are greatly indebted to him and to Dr. Kühnemann for the profitable stay we had in this remote part of the world. We wish to thank Dr. C. Dodge, Burlington and the curators of the herbaria for the loan of the type material. Mrs. G. Traute is thanked for skilled technical assistance and Dr. Nash for reading and correcting the manuscript.

ZUSAMMENFASSUNG

Die neue Art *Psoroma tenue* Henssen, eine Flechte auf Schneeböden und in Tundra-ähnlicher Vegetation gehört zur *Psoroma hypnorum*-Gruppe und ist am nächsten mit *P. cinnamomeum* Malme verwandt. Morphologie und Anatomie der beiden Arten werden verglichen. Sie stimmen in der Wuchsform, der Struktur des Lagers sowie in der Gestalt und Anatomie der Cephalodien weitgehend überein. Zwei Varietäten der neuen Art *P. tenue* werden unterschieden. *P. tenue* var. *tenue* ist auf die südliche Hemisphäre beschränkt und wurde bisher in Tierra del Fuego und auf den South Shetland Islands gesammelt. *P. tenue* var. *borealis* ist anscheinend eine weit verbreitete Flechte der nördlichen Hemisphäre; Fundorte werden für die Alpen, Skandinavien, Island und Nordamerika angegeben. Beide Varietäten von *P. tenue* enthalten den neuen Flechtenstoff Porphyrilsäuremethylester und Pannarinsäure, sowie in einigen der untersuchten Proben zusätzlich eine unbekannte Substanz (U_1). Das Vorkommen dieser Stoffe in anderen Arten der *P. hypnorum*-Gruppe wird erwähnt.

Psoroma bryantii Dodge und *P. follmannii* Dodge werden als Synonyme zu *P. hypnorum* (Vahl) S. F. Gray gestellt.

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AN UNDESCRIBED PLEOMORPHIC SPECIES OF *CODINAEA*

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In the course of an investigation of airborne fungi in Kobe, Japan, a hyphomycete was obtained in pure culture which proved to represent a previously undescribed species of *Codinaea* Maire. When grown on a variety of media such as cornmeal agar, malt extract agar, oatmeal agar, potato-carrot agar and potato-dextrose agar, sporulation is pleomorphic: It produces (a) polyphialidic, darker, thick-walled, and regularly septate conidiophores and allantoid, hyaline, 3-septate, and terminally setulate conidia characteristic of *Codinaea*, and (b) monophialidic, paler, and less septate conidiophores with fusiform non-septate conidia somewhat suggestive of *Chloridium*. Due to the latter features, the isolate superficially resembles *Chloridium codinaeoides* Pirozynski (1972), which produces monophialidic conidiogenous cells and narrowly fusiform-obclavate, aseptate conidia.

A recent account of the morphology and taxonomy of the genus *Codinaea* was given by Hughes and Kendrick (1968), who recognized 13 species and four anamorphic forms of *Chaetosphaeria* (Sphaeriaceae) and described in detail numerous collections from New Zealand. Subsequently the following 13 species have been added to the genus: *C. maharashtrensis* Pirozynski & Patil (1970), *C. novae-guineensis* Matsushima (1971), *C. eucalypti* Sutton & Hodges (1975), *C. septata* Sutton & Hodges (1975), *C. apiculata* Matsushima (1975), *C. lunata* Matsushima (1975), *C. britannica* M. B. Ellis (1976), *C. hughesii* M. B. Ellis (1976), *C. cylindrospora* Morgan-Jones & Ingram (1976), *C. unisetula* Morgan-Jones & Ingram

(1976), *C. clavulata* Holubová-Jechová (1976), *C. parkhalensis* S. M. & S. S. Reddy (1977), and *Codinaea* anamorph of *Striatosphaeria codinaeophora* Samuels & E. Müller (1978)(as '*S. codinaeaphora*'). *Dictyochaeta fuegiana* Speg., the type species of the genus *Dictyochaeta* Spegazzini that was considered as a possible earlier name for *Codinaea* (Hughes and Kendrick, 1968), has been re-described by Godeas et al. (1977). However, there are too few diagnostic features available on the type to properly define the type species of that genus.

Since none of the fungi of this genus are pleomorphic, the fungus from Kobe has been described here as a new species.

Codinaea dimorpha Toyazaki & Udagawa, sp.nov. (Figs. 1-6)

Coloniae in agaro "cornmeal" lente crescentes, tenuissimae, ex mycelio vegetativo submerso compositae; hyphae aeriae sparsae; conidia abundantia, aggregata, brunneo-grisea; reversum incoloratum. Coloniae in aliis agaris communibus celerius crescentes, planae vel rugosae, tenues, penitus auratae vel aurantiacae.

Mycelium immersum vel semi-immersum, ex hyphis hyalinis vel subhyalinis, ramosis, septatis, 1-3 μm diam, laevibus compositum.

Setae steriles absentes.

Structurae conidiogenae macronematae, dimorphae: (a) polyphialidicae et (b) monophialidicae. (a) Conidiophora ex hyphis repentibus superficialibus orientia, singula vel 2-3 aggregata, simplicia, brunnea, cylindrica, 200-280 × 6-8 μm, laevia, incrassata, omnino diametro uniformia, apicem versus pallescentia, recta vel flexa vel plerumque geniculata, usque 6-8 septata, superne successive elongascentia. Cellulae conidiogenae elongatae, cylindricae, vulgo usque ad 40-60 μm longae, polyphialidicae, raro discretae, determinatae, pallide brunneae vel subhyalinae, multis collaribus conspicuis praeditae; collaria infundibuliformia, 3-4 × 1.5-2.5 μm, subhyalina vel pallide brunnea, postremo effracta. Conidia semi-endogena, acropleurogena, hyalina, allantoidea, ellipsoidea vel oblonga, parum curva, 22-28 × 7-8 μm, 3-septata, laevia, ad basim interdum hilo inconspicue et utrinque setula singula, simplici, hyalina, 5-6 μm longa praedita, in massa mucida aggregata. (b) Conidiophora ex hyphis superficialibus singula oriunda, simplicia vel interdum irregulariter ramosa, 2-3 phialides ferentia, cylindrica, 45-100 × 2.5-4 μm, hyalina vel obscure olivaceo-brunnea, prope basin septata, laevia. Cellulae conidiogenae monophialidicae, integratae, determinatae, cylindricae, superne gradatim angustatae, collari distincto 2-2.5 × 1-2 μm praedita. Conidia semi-endogena, acrogena, hyalina, cylindrica vel fusiformia, 10-18 × 1-2 μm, parum curva, aseptata vel raro uniseptata, utrinque plus minusve truncata, in massa mucida aggregata.

Chlamydosporae terminales, obscure olivaceo-brunneae, ellipsoideae vel pyriformes, laeves, incrassatae, 10-15 × 6-10 μm, aseptatae vel raro uniseptatae.

Holotypus: cultura NHL 2891 ex aere urbis Kobe in Japonia, in 12.vi.1980, a N. Toyazaki, isolata. In collectione fungorum "National Institute of Hygienic Sciences (NHL), Tokyo, Japan."

Etymology: lat. *dimorphus* = having two forms, referring to the dimorphic conidiogenesis.

Colonies on cornmeal agar (CMA) growing slowly, reaching 2.8 cm in diam after two weeks at 23 C, very thin, vegetative mycelium largely submerged; white aerial hyphae sparsely developed on the agar surface; conidia-bearing structures abundantly produced in central colony areas, "brownish grey" (Kornerup and Wanscher, 1978; pl. 6-E-2); reverse uncolored. Colonies on malt extract-yeast extract agar (MYA) growing rather restrictedly, consisting of a somewhat thick basal felt, wrinkled conspicuously, velvety to floccose, producing abundant aerial hyphae, "pastel yellow" (Kornerup and Wanscher, 1978; pl. 2-A-4); conidia slowly developed, not affecting the colony appearance within three weeks; reverse "orange" (Kornerup and Wanscher, 1978; pl. 6-B-7). Colonies on oatmeal agar (OA) or potato-dextrose agar (PDA) growing more rapidly, reaching 3.0-3.6 cm in diam after two weeks at 23 C, plane, thin, "deep yellow" or "deep orange" (Kornerup and Wanscher, 1978; pls. 4-A-8, 5-A-8).

Mycelium immersed or semi-immersed, composed of hyaline to subhyaline, branched, septate, 1-3 μm wide, smooth-walled hyphae which often swell to knots of pale brown to brown cells up to 5.5-10 μm wide.

Sterile setae lacking.

Conidia-bearing structures macronematous, of two types; (a) polyphialidic, and (b) monophialidic. Type (a) commonly developed on CMA and at later stages also on MYA, OA and PDA. Conidiophores arising singly from superficially repent hyphae or in groups of two or three from hyphal knots, simple, brown, cylindrical, 200-280 × 6-8 μm, smooth and thick-walled, uniform in width throughout, paler towards the apex, straight or flexuous, often markedly geniculate in the upper region, up to 6-8-septate, successively proliferating with age at short distances. Conidiogenous

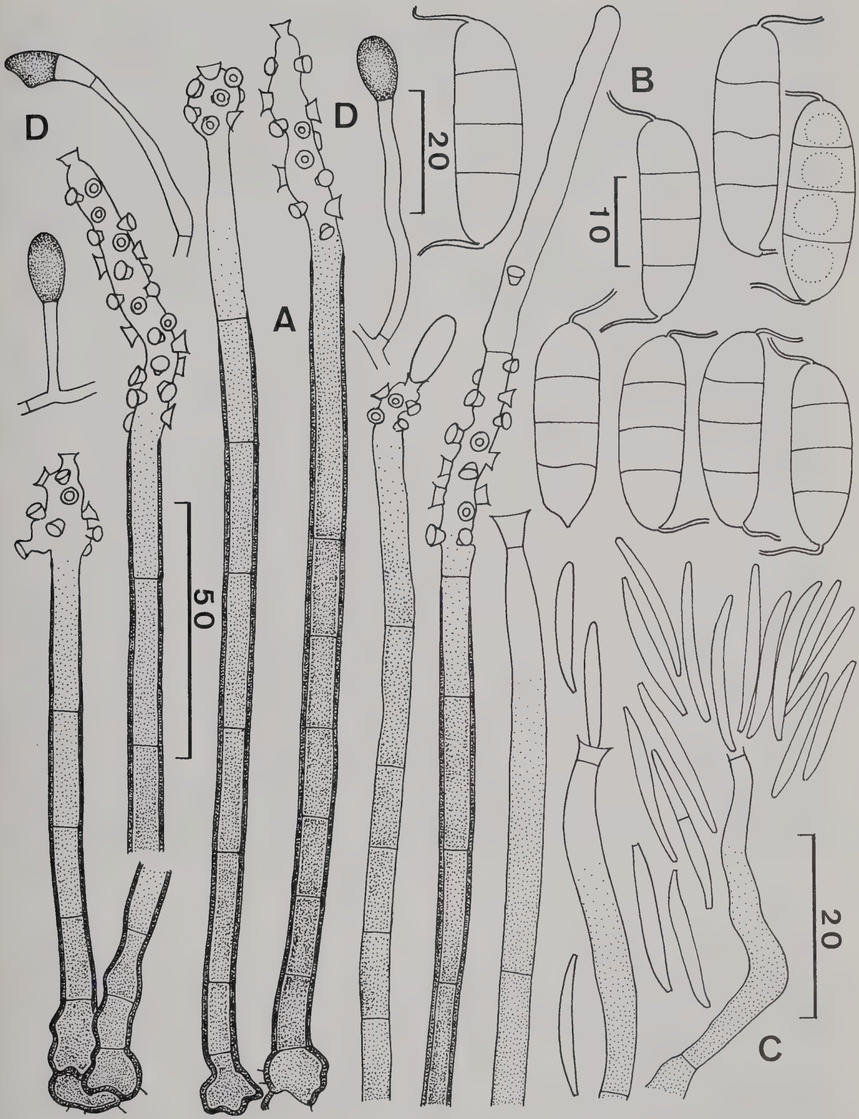
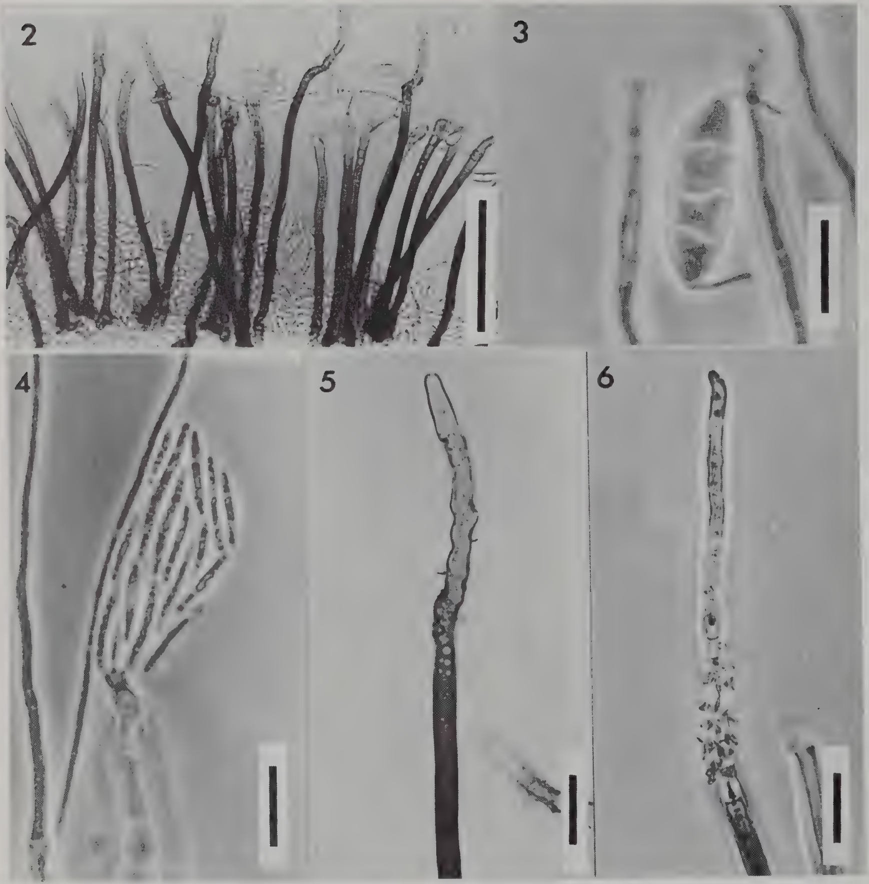


Fig. 1. *Codinaea dimorpha* (NHL 2891).
A. Conidiophores and polyphialides. B. Conidia(3-septate). C. Monophialides and conidia. D. Chlamydospores. (All measurements are in μm.)



Figs. 2-6. *Codinaea dimorpha* (NHL 2891).
2. Conidiophores. 3. Three-septate conidium. 4. Monophialidic conidiogenous cell and 0-1-septate conidia. 5 and 6. Polyphialidic conidiogenous cells. (Bars in 3-6 = 10 μm and in 2 = 100 μm.)

cells elongated, cylindrical, usually up to 40-60 μm in length, polyphialidic, rarely discrete, determinate, pale brown to subhyaline, each phialide in turn becoming externally scarred with the persistent remains of the collarettes; collarettes funnel-shaped, 3-4 × 1.5-2.5 μm, subhyaline to pale brown, aged ones often broken off. Conidia semi-endogenous, acropleurogenous, hyaline, allantoid, ellipsoid or oblong, slightly curved, 22-28 × 7-8 μm, 3-septate, smooth-walled, sometimes with a basal hilum, provided at each end with a single, simple, hyaline setula 5-6 µm in length, aggregated in a slimy mass. Type (b) developed at an early stage on MYA, OA and PDA. Conidiophores arising singly from superficial mycelium, simple or sometimes irregularly branching into two or three stalked phialides, cylindrical, 45-100 × 2.5-4 µm, hyaline to dark olive-brown, septate near the base, smooth-walled. Conidiogenous cells monophialidic, integrated, determinate, cylindrical, tapering gradually into a well-defined, terminal collarette measuring 2-2.5 × 1-2 µm. Conidia semi-endogenous, acrogenous, hyaline, cylindrical to fusiform, 10-18 × 1-2 µm, slightly curved, aseptate or rarely uniseptate, more or less truncate at both ends, aggregated in a slimy mass.

Chlamydospores often developed on MYA, OA and PDA, terminal, dark olive-brown, ellipsoid or pyriform, smooth, thick-walled, 10-15 × 6-10 µm, aseptate or rarely uniseptate.

At 37 C, no growth occurs.

Specimen examined: an isolate from air, at Kano-cho, Ikuta-ku, Kobe-shi, Japan, June 12th, 1980, N. Toyazaki, NHL 2891, holotype.

Of the species currently assigned to the genus, *C. dimorpha* somewhat resembles *C. fertilis* Hughes & Kendrick (1968) because of the crowded appearance of polyphialides which are produced at the portion where cylindrical conidiophores proliferate, and because it forms prominent phialide collarettes, as well as fusiform, curved and setulate conidia. It differs from *C. fertilis* in that it lacks sterile setae and has larger, 3-septate conidia and monophialidic conidiogenous cells.

Chloridium codinaeoides (*loc. cit.*) may be confused with the monophialidic fruiting structures of the present species, but in the former, conidia are smaller —— 5-9 × 1-1.5 µm as opposed to 10-18 × 1-2 µm in *C. dimorpha*.

The another superficially similar hyphomycete, *Hyphodiscosia europaea* Hol.-Jech. & Borowska has recently been described by Holubová-Jechová and Borowska (1981). Both are characterized by cylindrical, setulate phragmospores produced acropleurogenously at the elongating part of simple, erect, pigmented conidiophores. *Hyphodiscosia europaea* is distinct from the present fungus in that the conidia are sympodial-polyblastic and dark-colored at maturity, and in lacking a monophialidic conidia.

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The Psilopezioid fungi. VIII.

Additions to the genus *Pachyella*.

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SUMMARY

A review of the genus Pachyella *is given in view of recent collections from France and continued study by the senior author. One new species is proposed,* P. peltata, *and one new combination in made,* P. pseudosuccosa. *A key is given to the nine species now included in the genus.*

The senior author has revised the genus *Pachyella* (Pfister 1973) and emended its circumscription. The junior author has made significant new collections of species of the genus in France. This paper presents one new species of *Pachyella* from France, a report of *P. punctispora* from France, and a revision of the nomenclature of one species. A revised key to the genus *Pachyella* is given.

The literary history of the genus *Pachyella* was reviewed by Pfister (1973). Since that time several smaller contributions have been made (Pfister 1974, 1975). Pfister (1979) also added on species to the genus, *P. hydrophila* (Peck ex Sacc.) Pfister, and Berthet and Donadini (1978) described *Peziza aquatilis* which was later transferred to *Pachyella* by Donadini (1978). This species is discussed below.

A recent paper by Donadini (1980) should be mentioned. In it Donadini reduced *Pachyella* to the rank of a subgenus under *Peziza*. There is no indication that specimens were studied. Unfortunately several bibliographical improprieties have occurred.

We feel that *Pachyella* should be maintained as a distinct genus. The species are not only morphologically and anatomically distinct from *Peziza* but they are ecologically quite different as was pointed out earlier by Pfister (1973).

The following is a synopsis of the species now placed in *Pachyella*. Complete synonymies may be found for previously treated species in Pfister (1973).

Synopsis of species

Pachyella adnata (Berk. & Curt.) Pfist., Canad. J. Bot. 51: 2010. 1973.

Earlier *Aleuria annamitica* Pat. was added to the synonymy (Pfister 1974). Few additional collections have come to light. The distribution is wide but disjunct. Additional collections deposited in FH have been examined from Ohio (W. B. Cooke 48304) and Connecticut (DHP). The species is unreported in Europe. Donadini (1980) listed the authors as "(Berk. et Currey)" [sic].

Pachyella aquatilis (Berthet & Donadini) Donadini, see *P. pseudosuccosa*.

Pachyella babingtonii (Berk. & Br.) Boud., Hist. Class. Discom. Eur. p. 51. 1907.

Peziza exidiiformis Berk. & Br. may be added to the already lengthy synonymy. Donadini (1980) listed the authors of *P. babingtonii* as "(Berk. et Bres.)" [sic].

Pachyella clypeata (Schw.) Le Gal, Prodr. Flore Mycol. Madagascar 4: 27. 1953.

This species is still known only from North America though the new species described below from France is quite similar.

Pachyella hydrophila (Peck ex Sacc.) Pfister, Mycotaxon 8: 335. 1979.

This species and *Pachyella punctispora* are quite similar anatomically. Detailed field studies of *P. hydrophila* should be made--it is thus far only known from dried material.

Pachyella megalosperma (Le Gal) Pfist., Canad. J. Bot. 51: 2019. 1973.

No recent collections of this species have come to our attention. Comments on *Pachyella pseudosuccosa* should be seen below.

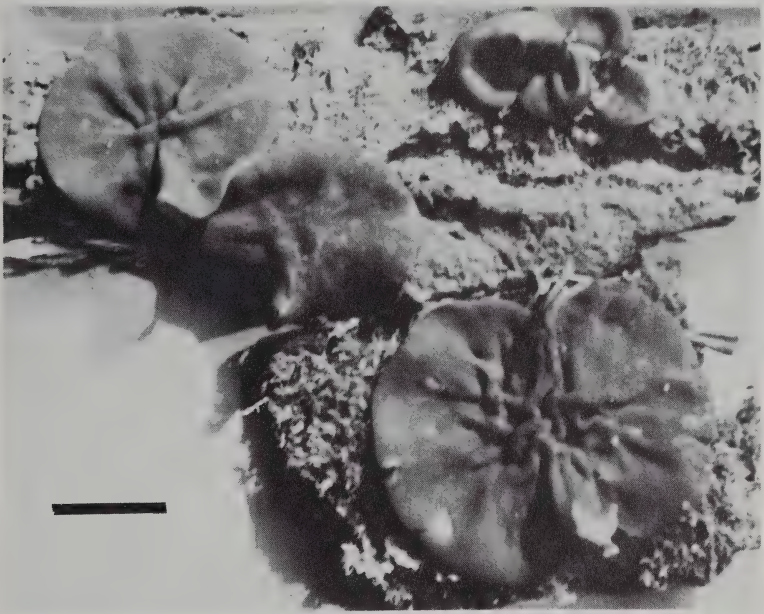

Figure 1. *Pachyella peltata*. Apothecia from the type collection. Scale = 2 cm.

Pachyella peltata Pfister & F. Candoussau sp. nov.

Figures 1 and 2

Apothecia 4-7 cm diam, planum, sessilia planae, similis Pachyella clypeata. *Hymenium brunneum. Excipulum exterium ex hyphis 55 x 25 µm compositum. Hyphis exteris rectis vel undulatis vel ramificans. Asci J+, 500 x 20-22 µm diam. Ascospori ellipsoidei, laevi biguttulati 27-30 x 13-15 µm. Paraphyses rectae, brunnae.*

Holotype: sur tronc de *Salix* pourri, à terre, endroit inondé périodiquement, avec *Psilopezia nummularialis* Pfist. & Candoussau et *Climacodon pulcherrimus* (Berk. & Curt.) Nikol. ainsi que sur *Alnus glutinosa* au même endroit. 14. IX. 1980. Forêt de Bugangue-Oloron, Pyrénées Atlantiques FH. Isotypes CUP and herb. Candoussau.

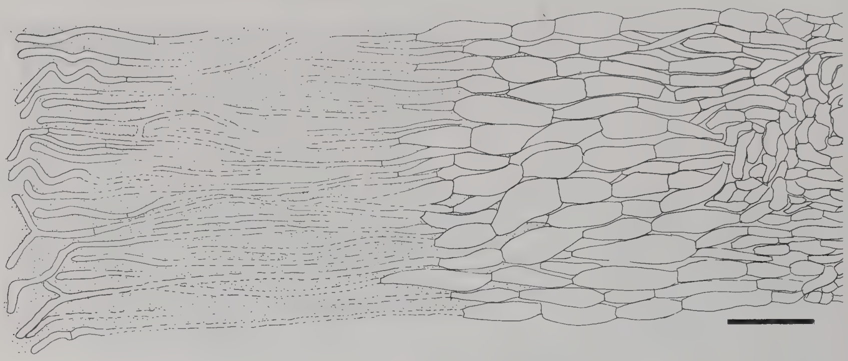

Figure 2. *Pachyella peltata*. Outer excipulum. Scale = 50 µm.

Apothecia gregarious 4 to 7 cm diam, sessile, flat, toward the center undulating--plicate as far as the margin. External surface dirty-white. Hymenium brown (chatain), shining, slightly viscous. Flesh, dirty white up to 3 mm thick at the center, tinted yellowish where broken. In external features agreeing closely with *P. clypeata* (Schw.) Le Gal.

Outer excipulum of longitudinally elongate cells with their long axes oriented perpendicularly to the outer surface of the apothecium, 3-5 cells deep, the larger of the cells measuring 55 x 25 µm or slightly larger. Cells tightly packed and only slightly swollen in width. The outer cells are uniformly embedded in a gelatinous matrix and give rise to hyphoid hairs of 5 to 7 µm in width to more than 400 µm in length, which often branch and anastomose or become moderately coiled.

Medullary excipulum of dense textura intricata, gel sparingly present, hyphae 6-12 µm in diam.

Asci diffusely J+, nearly 500 µm long and 20-22 µm broad.

Ascospores at maturity hyaline, thin-walled, smooth or with some cytoplasmic granulation, biguttulate but often obscurely so, 27-30 x 13-15 µm.

Paraphyses septate, enlarged above, exceeding the asci, of granular contents which become dark brown in fresh material when placed in iodine.

This species is quite similar to *Pachyella clypeata*; the spores are larger and the configuration of the hyphoid hairs differs. In habitat and growth form it is identical.

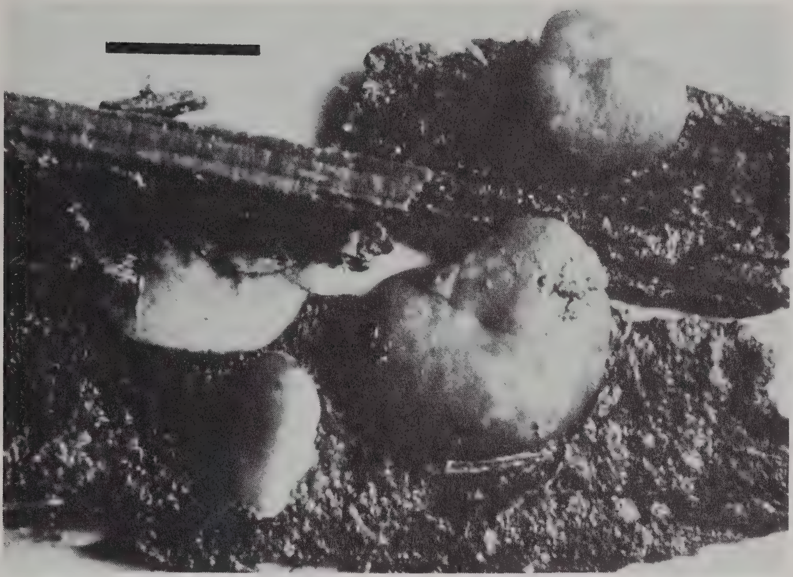

Figure 3. *Pachyella punctispora.* Apothecia from material collected in France. Scale = 1 cm.

Pachyella punctispora Pfist., Canad. J. Bot. 51: 2019. 1973. Figure 3
≡ *Peziza punctispora* (Pfister) Donadini. Doc. mycologiques 11: 26. 1980.

Pierre Gabard, Guy Roux and the junior author have collected this species in France (Pont du Goa, Vallée du Soussuéou, 900 m alt. 15.VII.1979; Crampes de Piet, Vallée d'Ossau, 800 m alt. Leg. Guy Roux, Pyr. Atlantiques, environs de Pau, s/Betula et autres bois, 28.VII. 1979). These collections constitute the first report of the species outside North America. Figure 3 shows apothecia of the French collection.

Pachyella pseudosuccosa (Le Gal) Pfister, comb. nov.
≡ *Galactinia pseudosuccosa* Le Gal, Rev. Mycol. (Paris) 10: 91-95. 1945.
? = *Peziza aquatilis* Berthet & J.-C. Donadini. Bull. Mens. Soc. Linn. Lyon 47: 205. 1978.
≡ *Pachyella aquitilis* (Berthet & Donadini) Donadini, Bull. Soc. Linn. Provence 31:. 18. 1978.

When Le Gal described *Galactinia pseudosuccosa*, she did so in such a way as to introduce some ambiguities, particularly in clearly stating the name in association with the Latin description. It seems to be validly published. One form she described, forma *macrospora*, was the form upon which *Galactinia megalosperma* (Le Gal 1953) was based. The typical form, material of which has been unavailable for study, was described from dried material in the Boudier herbarium and was collected by Barla in Nice in 1891.

A portion of the holotype specimen of *Peziza aquatilis*, kindly sent by M. Berthet, agrees closely with that described by Le Gal as *Galactinia pseudosuccosa*. Both have a reddish brown hymenium and both are said to produce a yellow juice when broken. Moreover, the Barla collection and those of Donadini are all from the same general area in S. W. France.

Pachyella violaceonigra (Rehm) Pfist., Canad. J. Bot. 51: 2021. 1973.

Previously the combination of this species in *Galactinia* by Boudier (Hist. Class. Discom. Eur. p. 47. 1907) was overlooked. Also to be added to the synonymy is the combination: *Peziza violaceonigra* (Rehm) Smits'Ka (Retsitsovi Gribi Ukrayini (Kiev) p. 78. 1975). Donadini (1980) also proposed the combination *Peziza violaceonigra*.

The junior author has made collections of *Pachyella violaceonigra* in France (Bois de St. Maur-Mirande, Gers, 13.VIII.1971; Forêt de Bugangue, Oloron, Pyr. Atlantiques 22.X.1973; FH, Herb. R. P. Korf, Herb. F. Candoussau). Other collections were made in Switzerland by A. Nyffenegger (near Kanton Bern; FH, Z) and by Bruno Erb and Stappung Erlinsback (automne 1980, Herb. F. Candoussau).

Key to species of *Pachyella*

1. Hyphoid hairs forming a palisade layer at the base of the apothecia 2
1. Hyphoid hairs not forming a distinct palisade layer at the base of the apothecia 7
    2. Ascospores smooth 13-16 x 18-25(28) µm, apothecia umber to chestnut color, outer layer of excipulum of radially arranged globose cells, hyphoid hairs neither branched nor anastomosing, N. America.... . . . . *P. clypeata*
    2. Ascospores or apothecial construction not as above 3
3. Ascospores smooth 13-15 x 27-30 µm, apothecia dark umber, outer layer of excipulum of tightly packed, only slightly swollen cells, hyphoid hairs branched and anastomosing, Europe. . . . .*P. peltata*
3. Ascospores variously ornamented 4
    4. Ornamentations taking the form of large flat-topped warts, N. America, West Indies, and Japan. . . . . *P. adnata*
    4. Ornamentations smaller in the form of warts or interconnecting ridges. 5
5. Spores ornamented with anastomosing warts, hymenium reddish brown, known only from Madagascar . . . . *P. megalosperma*
5. Spores ornamented with solitary warts 6
    6. Hymenium dark brick to sepia, when damaged not producing a yellow juice, Europe . . . .*P. violaceonigra*
    6. Hymenium reddish brown, when damaged producing a yellow juice, Europe . . . . . . *P. pseudosuccosa*

7. Spores smooth or punctate, margin attached to the substrate, apothecia generally not greater than 1 cm in diam, worldwide . . . . *P. babingtonii*
7. Spores ornamented with fine warts, margin free, apothecia generally larger than 1 cm 8
    8. Spores 12-15 x 21-25 µm, marked with small but discernable warts, paraphyses up to 9 µm, N. America, Europe . . . .*P. punctispora*
    8. Spores 13-16 x 22-26 µm, marked with warts which can scarcely be seen with the light microscope, paraphyses up to 15 µm in diam, N. America. . . . . *P. hydrophila*

ACKNOWLEDGEMENTS

We wish to thank Richard P. Korf for his comments on this manuscript. Prof. Berthet kindly sent material of *Peziza aquatilis* for our study. We are grateful to Emile Jarias and Guy Roux for photographs. The senior author's work was supported in part by National Science Foundation Grant DEB 8023018.

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MYCOTAXON

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PITHOMYCES PAVGII, A NEW COMBINATION FOR TRICHOCLADIUM PAVGII AND PITHOMYCES FUNICULOSA

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Trichocladium pavgii Nath was published as a new species from India on 16 July 1979 (1). Additionally, a new dematiaceous hyphomycete from Swaziland was described as *Pithomyces funiculosa* Palm, Stewart, & Rossman on 19 October 1979 (2). We have determined that *T. pavgii* and *P. funiculosa* are conspecific. *Trichocladium pavgii* has priority according to the International Code of Botanical Nomenclature, Article 11.3 (3). However, based on conidium development and secession, *T. pavgii* can only be accommodated in *Pithomyces* Berk. & Br. *Trichocladium* Harz has been broadly circumscribed and at present contains a heterogeneous assemblage of species which produce transversely septate conidia holoblastically. *Pithomyces*, in contrast, is characterized by the holoblastic production of dematiaceous conidia which are usually both transversely and obliquely septate. Moreover, rhexolytic conidium secession leaves a characteristic denticle on the conidiogenous cell. *Trichocladium pavgii* must be transferred to *Pithomyces*. The new combination is herein made and the taxon redescribed based on additional studies of isolates from India and the United States.

Pithomyces pavgii (Nath) Palm, Stewart, & Rossman, comb. nov. Figs. 1-4

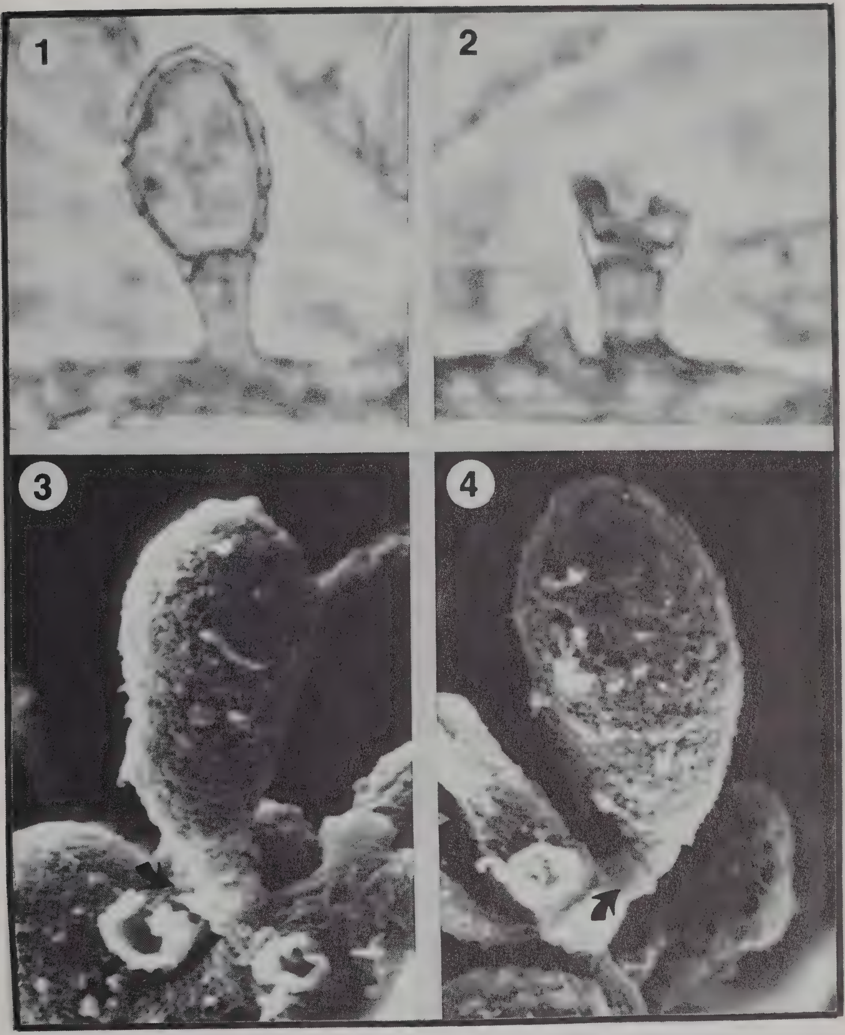
≡ *Trichocladium pavgii* Nath, Sydowia 31: 122-125. 1978. (basionym)

= *Pithomyces funiculosa* Palm, Stewart, & Rossman, Mycotaxon 10: 246-250. 1979.

COLONIES on malt agar white to grey becoming brown to black, floccose to appressed, dark ropy strands of conidiophores frequently present. HYPHAE septate, branched, of two types, hyaline to subhyaline, smooth, 1.5-5 ($\bar{x}=2.8$) μm diam, and subhyaline to pale brown, sometimes finely roughened, 2.5-6 ($\bar{x}=3.4$) μm diam. CONIDIOPHORES micronematous to semi-macronematous, mononematous, frequently funiculose, infrequently branched, septate, subhyaline to pale brown. CONIDIOGENOUS CELLS holoblastic, monoblastic or polyblastic, integrated, intercalary, determinate or seemingly proliferating percurrently to produce one or more conidia, cylindric to doliform, denticulate following secession of conidia, denticles short cylindric to doliform, 1-4 ($\bar{x}=2.4$) x 1.5-4 ($\bar{x}=2.3$) μm. CONIDIA solitary, pleurogenous, mostly verrucose, pale to dark brown, clavate to obovate to obpyriform to broadly or fusiform ellipsoid to reniform, transversely (0-)1-3(-4)-septate, mostly 2-septate, may be slightly constricted at the septa, rarely with 1-2 oblique or longitudinal septa, 10-17 ($\bar{x}=13.3$) x 4.5-12 ($\bar{x}=7.4$) μm (1-septate), 13-20 ($\bar{x}=17.2$) x 5-12 ($\bar{x}=7.8$) μm (2-septate), 17-26 ($\bar{x}=22.1$) x 6-12 ($\bar{x}=8.3$) μm (3-septate), bases 2-4 ($\bar{x}=2.6$) μm diam, with a portion of the conidiogenous cell usually remaining as a basal frill.

Collections examined: India: Hyderabad, Rajendranagar, V. Ravindra Nath. From kernels of *Arachis hypogaea* L. 3 i 1973 (IMI 205718 [holotype] and living culture received from V.R.N.). Swaziland: Luyengo, A.Y. Rossman. From fungal comb of *Macrotermes ukuzii* Fuller. 15 ix 1977 (MPPD). United States: Alabama, Chambers Co., G. Morgan-Jones. From municipal industrial waste-water. v 1980 (AUAM 2405).

In addition to its occurrence in India and Swaziland, G. Morgan-Jones (personal communication) has isolated *P. pavgii* in the United States. Based on our observations using phase contrast and scanning electron microscopy, the conidiogenous cell either proliferates percurrently through the denticle, which remains as a short annellation, or the apparently inelastic outer wall ruptures and remains at the base of the exposed, elastic inner wall. Remnants of conidiogenous cells surrounding the possibly proliferating conidiogenous cell are seen infrequently and mainly in older cultures. Ravindra Nath's line drawings of *P. pavgii* indicate flared structures resembling annellations at the apex of some elongate conidiogenous cells which he described as "roughened". Examination of the type material (IMI 205718) and of a living culture indicate that the



FIGS. 1-4. *Pithomyces pavgii.* 1. Photomicrograph (phase contrast microscopy for Figs. 1 and 2) of a developing conidium with intact outer wall. X2000. 2. Photomicrograph of a conidiogenous cell following rhexolytic conidium secession showing remnants of either the inner and outer walls or the walls from two successively produced conidia. X2000. Figs. 3-4. Scanning electron micrographs of conidium and conidiogenous cell with inelastic outer wall beginning to rupture (Fig. 3) and conidium and conidiogenous cell with ruptured outer wall or a possible annellation (Fig. 4). X3000.

fungus sometimes appears to proliferate percurrently, but, a conidiogenous cell so long and with more than one "annellation" was never observed by us. Final elucidation of conidiogenesis requires ultrastructural or time lapse studies or both.

ACKNOWLEDGEMENTS

This work was made possible in part by funds provided by the USDA, Forest Service, Forest Products Division (Nos. 12-39 and 12-144). We thank Dr. G. Morgan-Jones for the opportunity to observe and cite his isolate of *P. pavgii* and appreciate the helpful comments and suggestions of Drs. G. Morgan-Jones and W.J. Sundberg regarding the manuscript. Minnesota Agricultural Experiment Station, Scientific Journal Series, Paper No. 11,777.

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MYCOTAXON

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VALIDATION OF THE HERPOMYCETINEAE AND HERPOMYCETACEAE IN THE LABOULBENIALES

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When the Euceratomycetaceae in the suborder Laboulbeniineae was described (Tavares, 1980), a comparison was made between the development of the perithecia in the Laboulbeniineae and the Herpomycetineae I. Tav. (*nom. nud.*). Inadvertently, I omitted a reference to the second volume of Thaxter's monograph (1908) of the Laboulbeniales, in which the tribe Herpomyceteae was described in the key to genera within the family Laboulbeniaceae. In addition, there was no mention of the family Herpomycetaceae, nor was a diagnosis of the Herpomycetineae included (Tavares, 1980). Consequently, a Latin diagnosis for the Herpomycetineae follows, for which I am indebted to Dr. William J. Dress, Bailey Hortorium, Cornell University.

Subordo Herpomycetineae nom. nov. Dioeciae. Thallorum femineorum perithecia uno vel pluribus axibus receptacularibus secondariis, qui una vel pluribus cellulis suprabasalibus in axe primario producti sunt, portata. Perithecii paries exterior ex seriebus quattuor verticalibus cellularum constans, serie quaque ex cellulis numerosis brevibus altitudine subaequis composita. Cellula infima in una serie verticali cellularum parietalium perithecii juvenalis et introrsum et sursum per medium perithecii crescens, carpogonium formans. Antheridia sunt phialides.

Familia Herpomycetaceae (Thaxter) stat. nov.
Tribus Herpomyceteae Thaxter. Mem. Amer. Acad. Arts Sci. 13: 237. 1908.

Family Herpomycetaceae: As in the suborder. Dioecious, occurring on cockroaches (Blattaria). The germinating spore becomes transformed into a primary axis of four or more cells. In the female, perithecia are produced on secondary axes arising from the primary axis. Vertical septa are formed in the perithecial primordium, producing four cells, each of which divides into a vertical row of wall cells. When there are two tiers of wall cells, one of the four lower cells grows inward and upward and forms a central carpogonial upgrowth (Tavares, 1980). At maturity, there are many short outer wall cells, equal or subequal in height, in each vertical row. Four vertical rows of inner wall cells surround the passage in the perithecial neck through which the ascospores emerge (Tavares, 1966). Eight spores having median septa are formed in each ascus. Male thalli bear elongate, simple antheridia.

Thaxter's description (1908) of Herpomyceteae, which was only a brief statement in his generic key, nevertheless served satisfactorily to distinguish the tribe, because *Herpomyces,* the solitary genus, is the only dioecious genus having secondary receptacles and simple antheridia. Although *Dimeromyces aberrans* Thaxter (1924) may have simple antheridia, additional receptacular cells in the female thallus are produced in the primary axis and do not form a secondary axis as they do in the closely related genus *Dimorphomyces,* in which all antheridia are compound.

In his poorly preserved material, Thaxter was unable to see the internal structure of the perithecium of *Herpomyces* (see Thaxter, 1931). Consequently, he (Thaxter, 1908) placed *Herpomyces* in the Laboulbeniaceae because of the simple antheridia, not realizing how strongly its perithecial development differed from that of the other genera in this family.

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ERYNIA (ZYGOMYCETES: ENTOMOPHTHORALES): VALIDATIONS AND NEW SPECIES

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SUMMARY

New specific names are proposed to validate three heretofore invalidly published species of *Erynia* Nowakowski (Entomophthoraceae): *E. bullata* Thaxter & MacLeod in Humber, *E. creatonoti* Yen in Humber, and *E. myrmecophaga* Turian & Wuest in Humber. *Erynia formicae* Humber & Bałazy in Humber, sp. nov., is proposed as a name for a fungus occurring on ants and differing from the incompletely characterized *E. myrmecophaga*.

During recent studies on the entomopathogenic Entomophthorales, *Erynia* Nowakowski and the closely allied or synonymous genus (depending on one's taxonomic opinion) *Zoophthora* Batko have received much attention (Remaudière and Hennebert 1980; Remaudière and Keller 1980; Humber 1981, 1982; Humber and Ben-Ze'ev 1981; Ben-Ze'ev and Kenneth 1981, 1982). Several species referable to *Erynia* sensu Humber & Be-Ze'ev (1981) are not validly published under the International Code of Botanical Nomenclature. This paper validates three of these species and proposes a second new species of *Erynia* from ants.

ERYNIA BULLATA Thaxter & MacLeod, sp. nov.

CORPORA HYPHALIA variabilis per initium contagionis, hyphoidea postrem. NUCLEI persaepe conspicui, minimum 6-10 µm in diametro, contentis granulatis autem sine nucleolo conspicuo ovoideo centrali. CONIDIOPHORA dichotome digitate ramosa ad apices, intertexta in hymenium continuum; in taeniis emergens et in integumenta super corpore hospitis coalescens. CONIDIA PRIMARIA uninucleata, bitunicata, ellipsoidea ovoidea, 23.0-37.5 µm x 12.0-16.5 µm (medio 29.5 x 14.0 µm), expulsa vehementer eversione papillae distinctae contra conidiophora. CONIDIA SECUNDARIA inobservata. SPORAE PERDURANTES hyalinae vel stramineae vel pallidae alutaceae in massa in corpore hospitis; multinucleata ubi maturae; episporiis conspicue vel bullatis vel tuberculatis, 37-62 µm (medio 50 µm) in diametro toto bullis inclusis. RHIZOIDEA numerosa, simplicia, hyphoidea, sine haptero disciformi terminali, ex abdomine et thorace emergentia; in praesentia vel conidiorum vel sporarum perdurantium formata. CYSTIDIA desunt.

HYPHAL BODIES variable in size and shape during early stages of development in host, becoming hypha-like at time of the host's death. NUCLEI easily distinguished in most vegetative or reproductive structures; large, usually 6-10 µm or more in diameter; contents granular, without a prominent central ovoid nucleolus. CONIDIOPHORES branched digitately toward the apices, intertwining to form a continuous hymenium; emerging in bands from weak points of the host exoskeleton, coalescing to form more or less complete coverings over the abdomen and the junction of the neck and thorax. PRIMARY CONIDIA uninucleate, bitunicate, ellipsoid to ovoid, 23.0-37.5 µm x 12.0-16.5 µm (averaging 29.5 x 14.0 µm), forcibly ejected by the eversion of the conspicuous basal papilla against the conidiophore. SECONDARY CONIDIA not observed. RESTING SPORES forming a compact, hyaline to creamy-yellow or light tan mass inside the host body; multinucleate when mature; individual spores with prominent, rounded bullations up to 5 µm in height on the epispore; 37-62 µm (averaging 50 µm) in overall diameter (including the episporial bullations). RHIZOIDS numerous, unbranched, hypha-like, without any terminal disc-like holdfast, emerging principally from the abdomen and thorax; present whether the fungus produces conidia or resting spores.

HOLOTYPE: CUP 58970 (Cornell Univ., Plant Pathology Herbarium). Resting spores in *Sarcophaga aldrichi*. Coll.: D. Tyrrell, 23 June 1981.

PARATYPE: CUP 58971 (Cornell Univ., Plant Pathology Herbarium). Conidia on *Sarcophaga aldrichi*. Coll.: D. Tyrrell, 23 June 1981.

TYPE HOST: *Sarcophaga aldrichi* Parker (Diptera: Sarcophagidae).

TYPE LOCALITY: Birch Creek Road, Webwood, Ontario, Canada.

This species appears to be a relatively common pathogen of calliphorid and sarcophagid flies in North America. It was collected several times in the northeastern United States by Roland Thaxter (Riddle 1906, as *Entomophthora "x"*) but never formally described. After Thaxter's death, Povah (1935) received permission from Dr. W. Weston at Harvard University to use Thaxter's unpublished herbarium name, *Entomophthora bullata*, for the fungus Povah found attacking bluebottle flies in Michigan. This name, attributed to Thaxter, was presented with scant details of the fungus's morphology except for the bullate nature of its resting spores (33-50 µm diam. in Povah's collection) and the overall similarity of the primary conidia of this fungus with those of *Erynia americana* (Thaxter) Remaudière & Hennebert (1980). Unfortunately, *Entomophthora bullata* Thaxter in Povah appeared in print after 1 January 1935 and is, according to Article 36 of the International Code of Botanical Nomenclature, invalidly published without a Latin diagnosis or reference to any previously published Latin diagnosis. All subsequent combinations based on this name — *Zoophthora bullata* (Thax. in Povah) Batko (1966) and *Erynia bullata* (Thax. in Povah) Remaudière & Hennebert (1980) — are also invalidly published.

The most thorough study of *E. bullata* is that by MacLeod et al. (1973) who provide a complete morphological characterization. They suggest the host's age may affect whether conidia or resting spores are produced at the time of the fly's death. Kramer (1979) studied the time course of infection and the spore states produced in three species of calliphorid flies infected in the laboratory. He corroborated that the disease in younger flies does tend to produce only conidia while the probability for resting spore production increases with the age of the flies at the time of infectiong. In contrast to MacLeod et al. (1973), who state that the fungus never produced both conidia and resting spores in the same cadavers of field-infected *S. aldrichi*, Kramer (1979) found that, on rare occasions, both spore states may occur together in affected individuals of *Phormia regina* (Meig.) and *Phaenicia sericata* (Meig.). It is significant, then, to note that in the field-collected examples of *Sarcophaga aldrichi* in the holotype collection, tufts of conidiophores are apparent at the joints of the legs whereas the fly bodies are filled with resting spores. No bands of conidiophores are apparent on the abdomens of flies in the holotype collection.

Cytological studies by Riddle (1906) indicated that three-month-old resting spores of *E. bullata* are multinucleate. This condition was verified with resting spores from the holotype collection stained with either aceto-orcein or bismarck brown. Humber (1981a) discusses the implications of this multinucleate condition in entomophthoralean resting spores.

ERYNIA CREATONOTI Yen, sp. nov.

"CONIDIA pyriformia, uninucleata, med. 32 x 25 μm, basi papillata, muro tenui, cytoplasmatae granoso; NUCLEI med. 12 x 9 μm; CONIDIOPHORI ramosi coalescentes tegimenta suffusco vel roseo super totum hospitis corpus. CORPORA HYPHALIA brevia, segmentis hypharum incompositis, 8-28 μm latis 20-24 μm longis. CYSTIDIA raro inveniuntur. SPORAE PERDURANTES azygosporae (zygosporae pauca inventae), globosae; episporio laevi atque crasso; cytoplasma granosum vel vacuolatus; diam. 10-28 μm. Hospes substrato RHIZOIDEIS fixus." (Yen 1962)

TYPE: Latin and English descriptions and figure 1-4, *J. Insect Pathol.* *4*, 88-94 (1962).

TYPE HOST: *Creatonotus gangis* (L.) (Lepidoptera: Arctiidae)

TYPE LOCALITY: Kun-Kuan, Taipei, Taiwan.

This species, originally proposed with the orthographically incorrect name *Entomophthora creatonotus* Yen (1962), was invalidly published since no type was designated. The combinations *Zoophthora creatonoti* (Yen) Batko (1964) and *Erynia creatonoti* (Yen) Remaudière & Hennebert (1980) are also, therefore, invalidly published. The choice of the description and figures of *E. creatonoti* to typify this species is motivated by the lack of any mention by Yen (1962) of the permanent deposition of either any specimens or the slides from which his photomicrographs were prepared. The English description of all morphological characters of this fungus is meticulously detailed even if the figures are of limited utility.

The placement of this species in *Erynia* is fully justified by its uninucleate (presumably bitunicate) conidia borne on digitately brached conidiophores. The large nuclei are readily detected, even in unstained material (Yen 1962), and correspond to those of all other *Erynia* species. The presence of fascicles of hypha-like rhizoids and of a few cystidia supports this generic assignment.

ERYNIA FORMICAE Humber & Bałazy, sp. nov.

CORPORA HYPHALIA irregularia per initium contagionis, 35-155 μm x 8-16(20) μm, et posterius manifestius hyphoidea et saepe parciter septata. NUCLEI persaepe conspicui, magni, contentis granulatis autem sine nucleolo ovoideo centrali. CONIDIOPHORA in taeniis distinctis emergentia, dichotome vel digitate ramosa ad apices. CONIDIA PRIMARIA uninucleata, bitunicata, obovata vel pyriformia, 18-25 μm x 10-16 μm, expulsa vehementer eversione papillarum contra conidiophora; papilla basali aliquantum distincta. CONIDIA SECUNDARIA conidia primaria simulantia quanquam parviora, 16-19 μm x 10.5-13.5 μm, expulsa vehementer in modum conidiorum primariarum. RHIZOIDEA sparsa crassa, haptera disciformia terminalia, ex junctura promesothoracica in fasciculum laxum emergentia. CYSTIDIA et SPORAE PERDURANTES ignotae.

HYPHAL BODIES irregular in length, diameter, and branching pattern inside host body during early stages of development 35-155 μm x 8-16(20) μm, later becoming infrequently septate and more obviously hyphal in appearance. NUCLEI conspicuous in most vegetative or reproductive structures, large, with granular contents but no central nucleolus. CONIDIOPHORES emerging in distinct bands from weak points on the insect exoskeleton, dichotomously or digitately branched at the apices. PRIMARY CONIDIA uninucleate, bitunicate, obovate to pyriform, 18-25 μm x 10-16 μm, forcibly discharged by eversion of the more or less distinct papilla against the conidiophore. SECONDARY CONIDIA like the primary but smaller, 16-19 μm x 10.5-13.5 μm, forcibly discharged as in the primary conidia. RHIZOIDS relatively few in number, stout, terminating in a discoidal holdfast; emerging from the ventral thorax just behind the head, forming a loose fascicle. CYSTIDIA may be present; if so, tapering to a point from a relatively broad base. RESTING SPORES not observed.

HOLOTYPE: CUP 58975 (Bałazy 1285a), coll: J. Wiśniewski and A. Sokołowski, 19 Sept. 1977, Tuchola pine forest, Poland

PARATYPES: CUP 58976 (Bałazy 1286), CUP 58977 (Bałazy 2074a) and specimens retained by S. Bałazy and R. A. Humber.

TYPE HOSTS: Ants of the genus *Formica* (Hymenoptera: Formicidae): *F. polyctena* and *F. rufa*.

TYPE LOCALITY: Pine forests near Tuchola, Poland.

A comparison of entomophthoraceous fungi reported to attack ants in Switzerland (Turian and Wuest 1969, 1977), the Federal Republic of Germany (Loos-Frank and Zimmermann 1976), and Poland (Bałazy and Sokołowski 1977) indicates the existence of two distinct species of *Erynia*. *Erynia formicae* is described for the better characterized fungus (Loos-Frank and Zimmermann 1976; Bałazy and Sokołowski 1977); these collections have been attributed to the invalidly published and less completely characterized *Zoophthora myrmecophaga* Turian & Wuest (which is validated below as *Erynia myrmecophaga* Turian & Wuest).

The conidia of the Swiss fungus are smaller (averaging 18 x 12 μm), considerably more ovoid, and have a less conspocuous papilla than those of *E. formicae*. The conidia of the Swiss fungus but not of *E. formicae* have a single large vacuole occupying most of the conidial volume. In addition to being held onto grass blades by the mandibles and clasped legs, *E. formicae* further secures the ant cadavers with a few stout rhizoids emerging in a loose fascicle from the ventral thorax (Loos-Frank and Zimmermann 1976; Bałazy and Sokołowski 1977). This sort of rhizoid generally terminates in a discoid haptor (Batko 1966; Humber 1981a); although Loos-Frank and Zimmermann (1976) refer to a holdfast disc ("Haftscheibe") on the rhizoids, neither they nor Bałazy and Sokołowski (1977) illustrate the morphology of this holdfast. *Erynia myrmecophaga* has no such fascicle of rhizoids; Turian and Wuest (1977) report the presence of a few very fine rhizoids emerging from all portions of the host body.

The presence or absence of cystidia in *E. formicae* remains uncertain. Loos-Frank and Zimmermann (1976) note the presence of isolated, broad cystidia tapering to a point, but do not state where these occurred on the host, or at what stage of development. Bałazy and Sokołowski (1977) observed no cystidia on any specimens allowed to develop and sporulate in damp chambers.

Loos-Frank and Zimmermann (1976) provide a detailed study of the effects of *E. formicae* on its host, and find the behavior of affected ants and fungus-mediated histopathology of the brain to be much like the effects in ants caused by the parasitic trematode *Dicrocoelium dendriticum*. Humber (1975, 1976) also found a marked tendency for hyphae of *Strongwellsea magna* Humber to penetrate the thoracic ganglion and brain of affected flies, but without causing any obvious histopathology or changes in host behavior.

More complete information about the morphology and pathobiology of *E. formicae* is provided by Loos-Frank and Zimmermann (1976) and by Bałazy and Sokołowski (1977).

ERYNIA MYRMECOPHAGA Turian & Wuest, sp. nov.

CONIDIOPHORA parciter dichotome ramosa; in taeniis circum abdomen inter abdomen et occipitium et circum partes oris emergens. CONIDIA PRIMARIA uninucleata, bitunicata, late ovoidea vel pyriformia, medio 18 µm x 12 µm, vacuolam centraliam magnam conspicuam et guttulas oleosas sudanophilas numerosas continentia; papilla basali indistincta. CONIDIA SECUNDARIA conidia primaria simulantia sine vacuola quanquam parviora. Hospes ad substratum mandibulis et cruribus adhaerens.

CONIDIOPHORES sparingly dichotomously branched, emerging in bands on the abdomen, between the head and thorax, and around the mouth. PRIMARY CONIDIA uninucleate, bitunicate, braodly ovoid to pyriform, averaging 18 µm x 12 µm, containing a large central vacuole occupying most of the conidial volume and numerous sudanophilic oil droplets; basal papilla indistinct. SECONDARY CONIDIA similar to but smaller than primary conidia, but not containing the prominent central vacuole. Host attached to the substrate by the mandibles and clasped legs.

HOLOTYPE: Figs. 1, 2, and 4, *Mitt. Schweiz. Entomol. Ges. 50:*285-289 (1977).

TYPE HOST: *Serviformica fusca* L. (Hymenoptera: Formicidae).

TYPE LOCALITY: Sparse grasslands near Geneva, Switzerland.

This description of *E. myrmecophaga* is obviously fragmentary. There remains enough reasonable doubt about certain aspects included in the Latin description provided for *Zoophthora myrmecophaga* (Turian and Wuest 1977) that it was preferable to provide a wholly new description including only those characters which seem relatively well established.

Turian and Wuest (1969) found no rhizoids attaching ants affected by *E. myrmecophaga* to the substrate. These authors later described very fine rhizoids (Turian and Wuest 1977; Fig. 4) which are little distinguished from the epidermal hairs on the grass blades to which the ants are affixed. This characterization may actually note tru rhizoids of *E. myrmecophaga*, but their appearance is not typical of other entomophthoralean rhizoids. The possibility remains that these structures, observed on insects collected in 1967 and 1968, might have been either strands of insect or spider silk or the fine hyphae of some saprobic deuteromycetous contaminant.

Similarly, it is so unlikely that the two different types of "resting spores" noted by Turian and Wuest (1969. 1977) actually represent any over-wintering spores which might be produced by *E. myrmecophaga* that these spore types were intentionally omitted from the description and typification of this fungus above. Turian and Wuest (1969; Fig. 3) first reported finding one solitary resting spore among the hyphal bodies in one ant; this globose spore has a single-layered, relatively thin, smooth-surfaced wall, was 20 µm in diameter, and contained numerous oil droplets. If this was an entomophthoralean resting spore, it was immature and neither its size nor structure could be considered to be taxonomically significant. Turian and Wuest (1977; Fig. 3) later found a few globose resting spores with thick walls and rugose surfaces; the illustrated structure does not have the thick, two-layered wall which is characteristic of entomophthoralean resting spores. Neither were these rugose spores found in the numbers or aggregated mass in the abdomen that one might expect for naturally produced entomophthoralean resting spores. The best clue to the identity of these structures comes from the conspicuous furrows on the surface; this morphology is unprecedented in the Entomophthorales but is strongly reminiscent of tricolpate pollen grains like those produced by oaks and beeches (Fagaceae) (Faegri and Iversen 1975; Bassett et al. 1978).

Erynia myrmecophaga obviously requires further study from both any existing specimens and any future collections. Important differences between this species and the far better characterized *E. formicae* exist in the size and shape of the primary conidia, and the presence and nature of rhizoids. It should be noted, however, that the behavior and appearance of affected ants, the relatively low degree of conidiophore branching, absence of cystidia, and absence of verifiable resting spores are common characteristics of these species. None of the similarities is sufficiently important or convincing to suggest that *E. formicae* and *E. myrmecophaga* are not distinct species.

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A REVIEW OF THE NONENTOMOGENOUS ENTOMOPHTHORALES

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SUMMARY.

The characters used to define genera in the nonentomogenous Entomophthorales are evaluated and compared with those used for delimiting entomogenous genera. It is proposed that the host organism should be deemphasized. Five characters considered valid at the generic level are 1) spore karyology; 2) sporophore architecture; 3) method of spore discharge; 4) zygospore morphology and development; and 5) thallus development. These characters are applied to the fifteen nonentomogenous fungi reported to date, and two taxonomic realignments are proposed: *Meristacrum pendulatum* is transferred to *Zygnemomyces* and *Entomophthora vermicola* is transferred to *Macrobiotophthora*. The transfer of *Tabanomyces milkoi* to *Meristacrum* is accepted. *Ancylistes netrii*, originally described without a Latin diagnosis, is validated. The accepted genera are: *Ancylistes* (3 sp.), *Ballocephala* (3 sp.), *Completoria* (1 sp.), *Macrobiotophthora* (2 sp.), *Meristacrum* (2 sp.), and *Zygnemomyces* (2 sp.). A key to the species of these genera is provided.

I. INTRODUCTION.

Entomophthorales are separated from other orders of Zygomycotina by the forcible discharge of single spores and a tendency to parasitize insects. There are, however, a few saprobic species in *Conidiobolus* Brefeld and *Basidiobolus* Eidam, plus a small group of species parasitizing noninsect hosts. Humber (1981: p. 234) observes that ". . . it is inappropriate to argue about the choice of criteria used to define genera or about the correctness of one or another classification of the Entomophthorales without taking the non-entomogenous genera into full account." This paper attempts to render this accounting by reviewing published records, type and living material of these fungi, discussing the taxonomic criteria used to delimit the

TABLE 1.
REPORTS AND DESCRIPTIONS OF THE NONENTOMOGENOUS ENTOMOPHTHORALES.

1872. *Ancylistes closterii* Pfitzer, Monatsb. Königl. Preuss. Akad. Wiss. Berl. 396.

1874. *Completoria complens* Lohde, Tagebl. Versamml. Deutsch. Naturf. Aertze 47: 206.

1896. *Ancylistes pfeifferi* Beck, Verh. Zool. Bot. Ges. Wien 46: 233.

1912. *Macrobiotophthora vimariensis* Reukauf, Centralbl. Bakt. Parasit. Infeckt. 63: 390.

1940. *Meristacrum asterospermum* Drechsler, J. Wash. Acad. Sci. 30: 251.

1949. **Ancylistes netrii* Couch, J. Elisha Mitchell Sci. Soc. 65: 132.

1951. *Ballocephala sphaerospora* Drechsler, Bull. Torrey Bot. Club 78: 199.

1952. **Botryobolus parasiticus* Arnaud, Bull. Soc. Mycol. Fr. 58: 184. [=*Ballocephala sphaerospora*.]

1968. "A *Conidiobolus*-like fungus." Castaner, D. Mycologia 60: 440-443.

1970. †*Ballocephala verrucospora* Richardson, Trans. Brit. Mycol. Soc. 55: 308.

1973. *Coelomomyces milkoi* Dudka & Koval, Novitates System Plantarum non Vascularium 10: 89.

1973. *Zygnemomyces echinulatus* Miura, Rep. Tottori Mycol. Inst. (Japan) 10: 520.

1977. †*Entomophthora vermicola* McCulloch, Trans. Brit. Mycol. Soc. 68: 173.

1977. †*Meristacrum pendulatum* McCulloch, Trans. Brit. Mycol. Soc. 68: 175.

1978. *Ballocephala pedicellata* Pohlad & Bernard, Mycologia 70: 131.

1980. "*Conidiobolus* sp." Amin, E. & J. Webster, Trans. Brit. Mycol. Soc. 74: 334.

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* Invalidly published due to lack of Latin diagnosis.

† Type examined.

nonentomogenous genera, and proposing taxonomic revisions where necessary.

There have been 14 entomophthoralean fungi reported since 1872 from noninsect hosts, primarily from small animals (nematodes, tardigrades) or plants in moist environments (fern gametophytes, desmid algae). These fungi, as well as the entomogenous Tabanomyces milkoi Couch et al. [=Coelomomyces milkoi] are listed in Table 1 in order of their publication. The useful data obtained from these published descriptions, illustrations and photographs, and from the original material are summarized in Tables 2-5. Three nematophagous fungi are excluded from further consideration in this paper. Two parasites of Heterodera Schmidt (cyst-nematodes) were recently transferred to the Lagenidiales: Catenaria auxiliaris (Kühn) Tribe ([=Tarichium auxiliare Kuhn] MacLeod and Müller-Kögler 1970, Tribe 1980) and Nematophthora gymnophila Kerry & Crump ([='Entomophthora'-like fungus] Kerry 1974, Kerry and Crump 1980). Haptoglossa Drechsler was placed in the Entomophthorales by Ainsworth (1971), although Drechsler believed it belonged in the Saprolegniales, a disposition supported by Davidson and Barron (1973a) and Barron (1977).

II. EVALUATION OF TAXONOMIC CHARACTERS.

1. HOST.

Host range is often valuable as a taxonomic character for delimiting nonentomogenous species since none have yet been found from more than one host. In addition, nonentomogenous genera such as Ancylistes Pfitzer, Ballocephala Drechsler and Completoria Lohde are restricted to one host (see Table 2). However, as will be seen with the species placed at various times in Meristacrum Drechsler (M. asterospermum, M. pendulatum, Tabanomyces milkoi), it is possible for natural relationships to be obscured if host characteristics are not tempered with an understanding of basic aspects of morphology and development. The following examination of these characterisitics provide a better generic framework for the nonentomogenous Entomophthorales than can be obtained from host characteristics alone.

2. THALLUS DEVELOPMENT.

The initial stages of infection are similar in most nonentomogenous Entomophthorales, and involve the penetration of the cell wall or integument of the host by a thin penetration tube arising from a spore (especially a secondary spore) or appressorium formed at the tip of a sterile external hypha. Following penetration, the cytoplasmic contents of the infective propagule migrates into a swollen infection bladder. The thallus then matures from this bladder in one of three distinct patterns. In the nematode parasites (see Table 2), the thallus consists of long aseptate hyphae which more or less fill the host organism. These hyphae do not form short cells or fragment into

TABLE 2.
HOST AND THALLUS CHARACTERISTICS IN THE
NONENTOMOGENOUS ENTOMOPHTHORALES.

		INITIAL THALLUS				MATURE THALLUS			
SPECIES	HOST	form	length	x	width	form	length	x	width
Ancylistes									
closterii	D	AH	FH	x	7.5-11	SH	12.5-55	x	11-15
pfeifferi	D	AH	FH	x	7.5-14	SH	43-67	x	9.5-19
netrii	D	AH	FH	x	2.2-4.8	SH	15-30	x	8-15.5
Completoria									
complens	D	HC	15-30*	x	7-15	same	same		
Macrobiotophthora									
vimariensis	TD	?	?		?	HB	?		?
vermicola	N	AH	FH		5-7	SH	same		
Castaner (1968)	N	AH	FH		3-6.5	SH?	same		
Amin & Web.(1980)	N	AH	FH		?	SH?	18-23	x	12-18
Meristacrum									
asterospermum†	N	AH	50-500	x	5-12	HB	25-60	x	?
asterospermum°	N	AH							
milkoi	TB	AH	≥ 120	x	5-7	HB	70-176	x	28-56
Zygnemomyces									
echinulatus	N	AH	FH		2-5	same	same		
pendulatus	N	AH	FH		5-12	same	same		
Ballocephala									
sphaerospora	TD	AH	5-80	x	5-10	HB	40-80	x	5-10
verrucospora	TD	AH	?		?	HB	20-40	x	10-12
pedicellata	TD	AH	?		?	HB	20-31	x	13-16

All measurements in µm.
° Davidson and Barron (1973)
† Drechsler (1940)
* measured from illustration

D=desmid algae
F=fern gametophyte
N=nematode
TB=tabanid larvae
TD=tardigrade

AH=aseptate hyphae
HB=hyphal body
HC=hyphal cluster
FH=filling host
SH=septate hyphae

hyphal bodies at maturity.

In *Ancylistes*, *Ballocephala* and *Macrobiotophthora vimariensis*, after an initial mycelial stage, the hyphae become regularly septate. The newly formed cells may remain attached, or fragment into freely floating hyphal bodies, depending upon the physical activity of the host.

In *Completoria*, the infection bladder germinates and forms numerous short hyphal lobes which form a radiating cluster of cells filling the host cell completely. This is reminiscent of growth patterns in some of the entomogenous Entomophthorales (Thaxter 1888).

TABLE 3.
PRIMARY SPORE CHARACTERISTICS OF THE
NONENTOMOGENOUS ENTOMOPHTHORALES.

	PRIMARY SPORE							
SPECIES	shape	ornam	length	width	base	disch	#spore	devl
Ancylistes								
closterii	PYR	-	13.5-17.5		P	+	1	T
pfeifferi	PYR	-	21-23.5		P	+	1	T
netrii	PYR	-	16-25		P	+	1	T
Completoria								
complens	PYR	-	15-25		p	+	1	T
Macrobiotophthora								
vimariensis	OBV	-	18-21.5x10-11.5*		TR	?	1	T
vermicola	OBV	-	16-22 x 9-14		TR	+	1	T
Castaner (1968)	OV/B	-	6.5-9.5x6.5-8.5		TR	+	1	T
Amin & Web.(1980)	OBV	-	21-26 x 12-16		TR	+	1	T
Meristacrum								
asterospermum†	OBV	-	8-11 x 6-8		TR	+	5-15	B
asterospermum°	OBV	-	7-17.5x6-10		TR	+	2-8	B
milkoi	PYR	-	12-16 x10-13		P	+	4(3-1)	B
Zygnemomyces								
echinulatus	SPH	ECH	5.7-7.2		U	-	10-20	A
pendulatus	SPH	ECH	5-7		U	-	1-3	A
Ballocephala								
sphaerospora	SPH	-	3.0-4.5		U	+	20-80	A
verrucospora	SPH	ECH	4.5-6.0		U	+	4-12	A
pedicellata	SPH	-	6.7-8.0		U	+	2-10	A

All measurements in µm.
*Measured from published illustrations.
° Davidson and Barron (1973)
† Drechsler (1941)

ECH=Echinulate
OBV=Obovoid
OV/B=Ovate-Obovate
PYR=Pyriform
SPH=Spherical

A=Acropetal
B=Basipetal
P=Papillate
T=Terminal
TR=Truncate
U=Unmodified

3. PRIMARY SPORES.

Morphology.

Shape. Three basic spore shapes are found in the nonentomogenous Entomophthorales; all spores are of the unitunicate type (Remaudière and Hennebert 1980, Remaudière and Keller 1980). Ancylistes, Tabanomyces, and Completoria have pyriform spores (i.e. globose spores with conical papillae (Berdan 1938, Couch 1949, Leitgeb 1881) and are similar to those found in Conidiobolus. Meristacrum has obovate spores with truncate bases (Davidson and Barron 1973). And finally, Ballocephala (Drechsler 1951, Richardson 1970, Pohlad and Bernard 1978), Zygnemomyces echinulatus (Miura 1973) and Meristacrum pendulatum (McCulloch 1977) have globose spores lacking basal modifications.

Ornamentation. Spore ornamentation is uncommon in the *Entomophthorales*. Some species of *Massospora* Peck emend. Soper have verrucose spores, and the primary spores of *Conidiobolus coronatus* (Cost.) Batko may become villose by the growth of appendages through the spore wall. Spore ornamentations consisting of small echinulations are also found in *Ballocephala verrucospora*, *Zygnemomyces echinulatus*, and *Meristacrum pendulatum*.

Karyology.

The morphological characterisitics of nuclei are considered important by Humber (1981). The presence or absence of nucleoli and heterochromatin (and hence the staining ability of the nuclei) are taxonomically useful at the familial level (see §IV.3), and certain genera with similar spores (e.g. *Conidiobolus*, *Entomophaga* Batko) can best be distinguished using nuclear morphology. The number of nuclei per spore has been used to reveal the misplacement of individual species (e.g. *Culicicola* Nieuwland [Humber 1981]).

Unfortunately, few descriptions include karyological data, although there are a few exceptions among the fungi considered here. Hyphal bodies, gametangia and zygospores of *Ancylistes closterii* apparently have several nuclei with central nucleoli (Dangeard 1906). Couch (1949) was able to stain nuclei (weakly?) of *A. netrii* with lactophenol-cotton blue and confirmed Dangeard's earlier reports. Moorman (1976) also reported nucleoli in her study of mitosis in an unidentified species of *Ancylistes*. From these limited reports, it appears that *Ancylistes* is most similar to *Conidiobolus* in terms of karyology (Humber pers. comm.)

Two nonentomogenous fungi, *Completoria complens* (Humber pers. comm.) and *Entomophthora vermicola*, possess the heterochromatic nuclei lacking central nucleoli typical of *Entomophthora* Fresenius.

4. PRIMARY SPOROPHORES.

Spore Number.

Most entomogenous species produce only one spore per sporophore. Species of the entomogenous genus *Erynia* Nowakowski, while having apically branched sporophores, still produce only one terminal spore per branch. The nonentomogenous members, however, can be divided into two groups. Single-spored sporophores are found in *Ancylistes*, *Completoria*, and *Macrobiotophthora* Reukauf. Pleuri- or multispored sporophores are found in *Meristacrum*, *Tabanomyces* Couch et al., *Zygnemomyces* Miura and *Ballocephala*.

The number of spores in the multispored genera is actually quite variable (see Table 3). *Ballocephala* has two to 80 spores per sporophore, with most of this range attributable to variation between individual sporophores of *B. sphaerospora*. Similarly, *Meristacrum asterospermum* usually produces five to 15 spores (Drechsler 1940) but was found to produce as few as two (Davidson and Barron 1973).

Sporophore Septation and Spore Development.

Ballocephala produces sporophores with crosswalls at the base of lateral sporiferous branchlets. The main axis of the sporophore remains nonseptate, the spores are formed terminally, and then are pushed aside as the sporophore continues to elongate. Thus spores are formed and mature in acropetal succession. Acropetal spore formation is also observed in *Zygnemomyces echinulatus* and *Meristacrum pendulatum* (Figs. 1-2).

In *Meristacrum asterospermum* and *Tabanomyces milkoi* the sporophores become transversly septate, delimiting separate cells, each of which produces a single spore. Septum formation, and hence spore maturation, is basipetal.

5. PRIMARY SPORE DISCHARGE MECHANISM.

Ingold (1934, 1971) distinguished three types of spore discharge in the Entomophthorales: papilla-eversion (*Conidiobolus*), sporophore cannon (*Entomophthora*), and sporophore rocket (*Basidiobolus*). The method of spore discharge found in *Ballocephala* (see below) should be recognized as a fourth type, and fungi that have lost spore discharge could be placed in a fifth category.

The basic, and putative ancestral method of spore discharge (papilla-eversion) involves the separation of the wall layers of a columella which projects into the spore. The domeshaped columella that remains (more or less intact) after spore discharge and the everted conical or rounded papilla at the spore base are diagnostic for this release mechanism. *Ancylistes*, *Completoria*, and *Entomophthora vermicola* (with simple sporophores), *Tabanomyces milkoi* and *Meristacrum asterospermum* (with septate sporophores) have this type of spore discharge. The method of spore discharge was not seen in the "*Conidiobolus*-like fungus" (Castaner 1968) or *Macrobiotophthora vimariensis*, but can be reasonably inferred from their spore shape. All other spore discharge mechanisms are modifications of this basic method.

The second type involves a sporophore having a more or less swollen apex, and which ruptures just below the spore. In *Entomophthora* s. str., the spore is campanulate, has a flat base, and is carried away in a stream of sap shot from the collapsing sporophore. It should be noted that in *Entomophthora muscae* (Cohn) Fresenius, the secondary spores are discharged by the papilla eversion method.

The third discharge mechanism, found in *Basidiobolus*, involves the rupture of the base of a subspore swelling. This swelling tapers apically to a point forming a minute columella within the spore. The spore rockets away as the swelling expels fluid from its torn end, and lands with or without the remnants of the vesicle still attached to the everted spore base. The claim that this is a two-stage rocket is probably more fanciful than accurate, as the decrease in turgor pressure within the sporophore must be accompanied by the simultaneous release of spore turgor by the eversion of the papilla.

TABLE 4.
SPOROPHORE AND SECONDARY SPORE CHARACTERISTICS IN THE NONENTOMOGENOUS ENTOMOPHTHORALES.

	SPOROPHORE			SUBSPORE CELL		2° SPORES	
SPECIES	length	width§	septn	length	width	replic	disch
Ancylistes							
closterii		3-7.5	-	-	-	++	+
pfeifferi		4-7	-	-	-	+	+
netrii	25-100	8	-	-	-	+	+
Completoria							
complens	60-80	?	-	-	-	+	?
Macrobiotophthora							
vimariensis		4-5	-	-	-	+	-
vermicola	27-50	6-8	-	-	-	+	-
Castaner (1968)	<60	1.5-3	-	-	-	+*	+
Amin & Web.(1980)	<60-90	?	-	-	-	+	+
Meristacrum							
asterospermum†	200-500	6-9(3-5)	+(S)	-	-	+	-
asterospermum°	60-500	5-9(3-5)	+(S,U)	-	-	+	-
milkoi	90-200	7-8(4-6*)	+(U)	-	-	+	-
Zygnemomyces							
echinulatus	100-750	2.7-5.7	-	1.5-3	.5-1.1	-	-
pendulatus	18- 71	2-3	-	1-3		-	-
Ballocephala							
sphaerospora	50-175	4-5	-	4-7	3-4.5	-	-
verrucospora	50-150	5-7	-	5-7	5-7	-	-
pedicellata	33- 73		-	2.1	1.6-2.6 (1.1-1.6)	-	-

All measurements in µm.
* measured from published illustrations
† Drechsler (1941)
° Davidson and Barron (1973)

S=Spiralled sporophores
U=Unspiralled sporophore
++=produces 2°+ 3° spores
**=produces microspores
§(narrowest width)

The sporophore discharge mechanism found in *Ballocephala* constitutes a fourth type. All species of *Ballocephala* have spherical spores lacking basal modifications, but are subtended by a special cell (separated from the sporophore by a crosswall) whose rupture discharges the spore. Drechsler (1951) proposed that this cell was, in fact, the undischarged primary spore which produces a premature secondary spore, a hypothesis which is consistent with the basic developmental patterns of the Entomophthorales. In *B. sphaerospora* and *B. verrucospora*, the spore bearing cells are utriculate, asymmetrical, curved upwards, and as large as the spore (Drechsler 1941, Richardson 1970). *Ballocephala pedicellata* has ovoid to broadly obpyriform pedicels which are much smaller than the spores. Spore discharge in this species is likely, although the evidence is circumstantial (Pohlad and Bernard 1978).

Spore discharge is lacking in Zygnemomyces echinulatus and Meristacrum pendulatum. In both species, the apex of the sporophore gives rise to a terminal spore lacking basal modifications, and then proliferates sympodially. The resulting pedicels are not delimited by a crosswall, although they may become devoid of cytoplasm. Thus, they are of distinctly different origin than the sporiferous cells of Ballocephala.

6. 'SECONDARY' SPORES.

If forcible spore discharge is a key characterisitic of the Entomophthorales, so too is the ability of the discharged spores to produce 'secondary' spores (Table 4). In almost every member of the order, primary spores that land on hostile substrates can produce replicative spores which are forcibly discharged. These spores are also called repetitive, or secondary (2°), tertiary (3°), etc. spores. Exceptions to this rule are Ballocephala spp., Zygnemomyces echinculatus, and Meristacrum pendulatum.

Two additional types of 'secondary' spores have been taxonomically useful. Microspores ("multiplicative spores" Drechsler 1952) are formed and discharged from single primary spores of various species of Conidiobolus. Basidiobolus microsporus Benjamin produces elongate passively detached "microspores" by a totally unrelated method (Benjamin 1962, Tucker unpubl.). Microspores are also found in the "Conidiobolus-like fungus" (Castaner 1968) but are otherwise absent in nonentomogenous species.

Capillispores ("capilloconidia" Remaudière and Hennebert 1980; "elongated secondary conidia" Drechsler 1955) are usually slightly thick walled, ovoid, ellipsoid (or slightly irregular in shape), without modifications of the spore base and borne on long slender sporophores ("capillary conidiophores" Thaxter 1888). The loss of spore discharge is apparently counterbalanced by the increased infective potential or likelihood of dispersal by a passing host. True capillispores are produced only by Basidiobolus. Nondischarged spores borne on tapering sporophores, are found in Meristacrum asterospermum, Macrobiotophthora vimariensis, and Entomophthora vermicola.

7. RESTING SPORES.

Morphology and Development.

Resting spores, whose function is one of perennation rather than dispersal, are usually thick walled and formed within the vegetative mycelium. The distinction between zygospores (developing following conjugation) and azygospores (developing without conjugation) has been questioned (Humber 1981), but is here considered provisionally useful (see below). Virtually all of the nonentomogenous Entomophthorales produce resting spores of one form or another (see Table 5).

Ancylistes, as in Conidiobolus, forms zygospores after scalariform or lateral conjugation of unequal gametangia

TABLE 5.
RESTING SPORE CHARACTERISTICS OF THE NONENTOMOGENOUS ENTOMOPHTHORALES.

	ZYGOSPORANGIUM				ZYGOSPORE / AZYGOSPORE			
SPECIES	con	form	length	width	shape	color	orn	diameter
Ancylistes								
closterii	U	GB	APPRESSED		SPH	BRN	none	14.5-20
pfeifferi	U	G	30-40		SPH	BRN	none	18.5-22
netrii	U	CT	APPRESSED		SPH	?	none	19-26
Completoria								
complens	E?	GB	APPRESSED		SPH	-	none	17-33*
Macrobiotophthora								
vimariensis	-	-	-		-	-	-	-
vermicola	E	CT	APPRESSED		DDC	-	none	19-20
Castaner (1968)	-	-	-		-		-	-
Amin & Web.(1980)	-	-	-		-	-	-	-
Meristacrum								
asterospermum†	-	HB	LOOSE		SPH	YEL	UND	20
asterospermum°	-	HB	LOOSE		SPH		UND	15-20
milkoi	E	G	APPRESSED		OVD	-	none	12-20x23-30
Zygnemomyces								
echinulatus	E	HB/CT	22-28*		OCT	BRN	none	16-24
pendulatus	?	HB			POL	-	none	18-24*
Ballocephala								
sphaerospora	E	HB	28-33x14-16.5		DOL	BRN	none	17-20x13-16
verrucospora	-	-	-	-	-	-	-	- -
pedicellata	E	HB	APPRESSED		DOL	BRN	PUNC	20.6-26.6 x 17.3-18.6

All measurements in µm.
*Measurements from published illustrations.
†Davidson & Barron (1973)
°Drechsler (1940)

orn=ornamentation
PUNC=punctate
UND=Undulate

con=conjugation
E=equal gametangia
U=unequal gametangia
dev=zygosporangia develope from or within:
CT=Conjugation tube
G=Gametangium
GB=Gametangial bud
HB=Hyphal body

(color)
BRN=Brown
YEL=Yellow

(shape)
DDC=Dodecahedral
OVD=Ovoid
POL=Polygonal
SPH=Spherical

(Pfitzer 1872). The presence of numerous protrusions on the zygosporangial wall is used to separate A. pfeifferi from other species of the genus (Berdan 1938, Couch 1949).

Completoria forms one to ten (or 20) round to oval, thick walled resting spores within the enlarged cells in the central portion of the hyphal mass. (The peripheral cells of the thallus are by this time emptied by the formation of primary sporophores or infective hyphae.) Conjugation has not been observed (Atkinson 1884, 1885).

Zygnemomyces echinulatus forms brownish, thick walled, octangular zygospores following scalariform conjugation. The octangular shape results from the position of the zygospore in the conjugation tube between the two parental hyphal bodies (Fig. 1E). The resting spores of Meristacrum pendulatum are similar in shape (Fig. 2F), but the mode of development is unknown.

Entomophthora vermicola forms zygospores after scalariform or lateral conjugation (Fig. 3K-P). At maturity, these zygospores are dodecahedral, each face with 5 (4-6) raised edges and a central depression (Fig. 3P).

Conjugation in Ballocephala has not been proven, although its occurrence was inferred by Drechsler (1951) from the presence of two slightly inflated locules at either end of the zygospore. The zygospore itself is doliform or cylindrical, brown to dark-brown in color, smooth or punctate, and is preferentially formed at reduced temperatures (5° C) (Pohlad and Bernard 1978).

Meristacrum asterospermum was described by Drechsler (1940) as forming azgyospores by the rounding up of the cytoplasm of a thalloid segment, laying down of retaining walls at either end, and deposition of a new undulate or scalloped wall around the cytoplasm. The star-shaped resting spore is colorless or slightly yellowish, is about 15-20 um in diameter, and contains a single large oil droplet.

Finally, in Tabanomyces milkoi, uninucleate, spherical gametangia fuse in pairs with the contents of one gametangium migrating into the other and forming a smooth, colorless ovoid zygospore with a single diploid nucleus (Couch et al. 1979, Nam and Dubitskii 1977).

Zygospores vs. Azygospores: A Different Perspective.

Resting spores have been used for taxonomic purposes to some extent, but recent treatments of the family (Remaudière and Keller 1980, Humber 1981) have cautioned against some traditional applications of resting-spore characteristics. In particular, the distinction between zygospores and azygospores (with respect to conjugation) was discussed at great length by Humber (1981), who dismissed it for two reasons. First, the development of (a)zygospores is often difficult to follow or interpret, and hence published accounts may be misleading. This objection is valid, and the presence or absence of conjugation must be used with caution. However, the second objection, that the nuclear events of karyogamy and meiosis are of more importance to the fungus than whether conjugation occurs, poses an interesting question.

Of what importance are the sexual events of conjugation, karyogamy and meiosis to the entomophthoralean fungi? It must first be noted that all "sexual" Entomophthorales are homothallic (automictic) and homomictic (i.e. no mating types exist). Conjugation, when it occurs, is between cells of the same branch or between hyphal bodies. Secondly, since most spores and hyphal bodies are multinucleate, genetic recombination may occur somatically rather than during meiosis. There are very few species in the Entomophthorales for which evidence of meiosis exists (exceptions include Conidiobolus thromboides Drechsler= Entomophthora virulenta Hall & Dunn, Tabanomyces milkoi). The lack of data on basic aspects of sexual events and genetics is a great hindrance in attempts to assess the importance of zygospores or to understand evolution within the order.

Retaining the ability to coevolve with host organisms is likely to be important to these fungi, but it is also apparent that the presence or absence of conjugation or of karyogamy and meiosis do not seem to be as critical. Perennation and infective ability, however, continue to be important as a basic requirement of the entomophthoralean life cycle. The formation of the resting spore, whether induced by conjugation or not, involves the phenotypic expression of extensive portions of the genome, and thus the shape, size, or ornamentation of resting spores may ultimately be of more taxonomic significance than nuclear events.

8. SUMMARY OF TAXONOMIC CHARACTERS.

From the preceding discussion of morphological characters in the nonentomogenous Entomophthorales, it should be clear that character diversity within the order is greater than that encompassed by the entomogenous members alone. Nevertheless, the three characters which Humber (1981) proposed as most valuable in delimiting genera: "nuclear number and nature," "sporophore branching," and "method of spore discharge," apply as well to the nonentomogenous genera, and the assessment of these characters needs only minor revision.

1. Spore karyology, i.e. nuclear morphology and number per primary spore, remains important in distinguishing natural groups (i.e. families) within the Entomophthorales (see §IV.3). This may be of practical value for separating morphologically similar genera (e.g. Conidiobolus from Entomophaga; or Ancylistes from Completoria).

2. Spore discharge is virtually universal within the order and thus is presumably an ancestral character. The spore discharge "theme" has five variations: papilla-eversion (Entomophthoraceae, Ancylistaceae), sporophore-cannon (Entomophthoraceae), Ballocephala-type (Ancylistaceae), and sporophore-rocket (Basidiobolaceae), plus the loss of discharge (Entomophthoraceae [Massospora], Ancylistaceae [Zygnemomyces]).

3. Sporophore architecture now includes the presence or absence of sporiferous branchlets or transverse septations as well as branching of the sporophore. In addition, the mode of spore formation (basipetal, acropetal, or terminal) which is linked to sporophore septation, can be used to distinguish genera. It is presumed that the unispored sporophore is ancestral, and that multispored sporophores are derived.

4. Zygospore morphology, which Humber (1981) discounted but actually used as a secondary characteristic to delimit Triplosporium (Thaxter) Batko, is most appropriately used for delimitation of species or subgenera.

III. GENERIC TAXONOMY AND REVISIONS.

ANCYLISTES Pfitzer,
Monatsb. Königl. Preuss. Akad. Wiss. Berlin. 396. 1872.

Type species: Ancylistes closterii Pfitzer, Monatsb. Königl. Preuss. Akad. Wiss. Berlin. 396. 1872.

Other species:

Ancylistes pfeifferi Beck, Verh. Zool.-Bot. Ges. Wien 46: 233. 1896.

Ancylistes netrii Couch, J. Elisha Mitchell Sci. Soc. 30: 251. 1949. Validation of this species is here accomplished with the publication of the following Latin diagnosis:

Hyphae asumentes primum aseptatae 2.2-4.8 µm crassae, tum ramosae et septatae, cellulis 15-30 X 8-15 µm; hyphae exitibus unica in cellula una factae, 2-4 µm crassae, parietem hospitis juxta tumidae usque ad 4-9 µm emergentes et hyphas externas facientes, quae hospitem proximum obnoxium inficunt, aut si ex aqua emergunt sporophora 25-100 µm faccunt; sporae primigenae 16-25 µm crassae papillis conicis; zygosporae intra hospitem inter aliquot hyphas longitudinales seriales formatae, ut videtur conjugatione cellulis duabus hyphis oppositis, zygosporis intra tubum conjugentem, sphaericus vel subsphaericis 19-26 µm crassis. Hospe: Netrium (Desmidiaceae).

Ancylistes is in many ways, similar to Conidiobolus, especially in spore shape and karyology (see §IV.2, IV.3). The species are divided on the basis of host (saccoderm or placoderm desmid algae), size of the primary spore, and zygosporangial morphology. See Berdan (1938) and Couch (1949) for a treatment of this genus.

BALLOCEPHALA Drechsler,
Bull. Torrey Bot. Club 78: 199. 1951.

Type species: Ballocephala sphaerospora Drechsler, Bull. Torrey Bot. Club 78: 199. 1951.

Other species:

Ballocephala verrucospora Richardson, Trans. Brit. Mycol. Soc. 55: 308. 1970.

Ballocephala pedicellata Pohlad & Bernard, Mycologia 70: 131. 1978.

This genus, found only in tardigrades, is unique in the manner in which the spores are formed and discharged. As previously mentioned (see §II.4, II.5), the discharged spore may actually be a secondary spore developing neotenously from the undischarged primary spore, which is present in the form of a utriculate vesicle or a reduced pedicel. The species are separated on the basis of spore ornamentation and the morphology of the sporiferous cell.

COMPLETORIA Lohde,
Tagebl. Versamml. Deutsch. Naturf. Aertze 47: 206. 1874.

Type species: Completoria complens Lohde, Tagebl. Versamml. Deutsch. Naturf. Aertze 47: 206. 1874.

This rare parasite of fern prothalli has been reported only twice since the original description (Leitgeb 1881, Atkinson 1884, 1885). The presence of large stainable nuclei lacking central nucleoli and a thallus composed of short hyphal branches indicate a distant relationship with most other nonentomogenous Entomophthorales. It is placed in the Entomophthoraceae (see §IV.3).

MERISTACRUM Drechsler emend. Tucker & Humber,
J. Wash. Acad. Sci. 30: 250. 1940.

Type species: Meristacrum asterospermum Drechsler, J. Wash. Acad. Sci. 30: 251. 1940.

Vegetative hyphae developing within living animals, simple to somewhat branched, at first continuous, later dividing into disjointed segments which put forth a sporophore into the air, the terminal portion dividing basipetally, forming several to few cells, each of which produces a single spore forcibly discharged by papilla-eversion; secondary spores replicative or passively detached; resting spores azygospores formed from hyphal segments or zygospores formed from conjugation of spherical uninucleate gametangia.

Other species:

Meristacrum milkoi (Dudka & Koval) Humber, Mycotaxon 13: 232. 1981.
Basionym: Coelomomyces milkoi Dudka & Koval apud Dudka, Koval & Andreeva, Novitates Systematicae Plantarum non Vascularum 10: 89. 1973.
Synonym: Pseudocoelomomyces milkoi Nam and Dubitskii, Inst. Zool. Alma Ata, Acad. Sci. Kazakh. SSR (VINITI no. 1309-77 Dep.). 1977. (Lacking Latin diagnosis.)
Synonym: Tabanomyces milkoi (Dudka & Koval) Couch, Andreeva, Laird, & Nolan, Proc. Natl. Acad. Sci. (U.S.A.) 76: 2300. 1979. (Deficient basionym cit.)

Tabanomyces milkoi was transferred to Meristacrum by Humber (1981) because of the similarity in their sporophore development. In M. asterospermum and M. milkoi, transverse septa are layed down in basipetal succession, with each of the newly formed cells producing a spore which is discharged by papilla-eversion. This mode of sporophore development is not found elsewhere in the Entomophthorales, and is the single most important character in delimiting the genus.

The difference in host organism is of questionable value at the generic level, and the non-helicoid sporophore of *M. milkoi* is of no significance since Davidson and Barron (1973) observed a similar lack of spiralling in sporophores emerging from resting spores of *M. asterospermum*.

There are, however, three differences between these two species which may be used to divide *Meristacrum* into subgenera when a fuller understanding of these and other as yet undiscovered species is obtained.

Character	*M. asterospermum*	*M. milkoi*
1) Primary spore	obovoid, truncate base	globose basal papilla
2) Secondary spore	obovoid passively detached	globose replicative
3) Resting spores	azygospores spherical, undulate conjugation (-)	zygospores ovoid, smooth conjugation (+)

The resting spore characteristics are the most significant.

ZYGNEMOMYCES Miura emend.,
Rep. Tottori Mycol. Inst. (Japan) 10: 520. 1977.

Type species: *Zygnemomyces echinulatus* Miura,
Rep. Tottori Mycol. Inst. (Japan) 10: 520. 1977.

Vegetative hyphae developing within living animal, unsegmented, giving rise to sporophores; sporophores nonseptate, bearing spores on pedicels formed from the sporophore apex, proliferating sympodially at the apex or subapically; primary spores globose, echinulate, produced acropetally, not forcibly discharged; secondary spores absent; zygospores thick walled, forming after lateral or scalariform conjugation.

Other species:

ZYGNEMOMYCES PENDULATUS (McCulloch) comb. nov.,
Basionym: *Meristacrum pendulatum* McCulloch, Trans. Brit. Mycol. Soc. 68: 175. 1977.

Body of the infested nematode containing unsegmented allantoid thalli, 2-5 μm wide; sporophores erect, unsegmented, 18-71 μm long, after penetrating the host cuticle forming an apical hook upon which a single terminal spore develops, growth continuing by sympodial proliferation; sterigmata formed from the sporophore hook, becoming emptied of cytoplasm, 2-3.5 μm wide proximally, tapering to 0.8-1.2 μm wide at the spore; spore spherical, echinulate, 5-8 μm in diameter, adhering to the nematode when detached; resting spores 18-24 μm, thick walled, with a single large oil drop, found within dead nematodes.

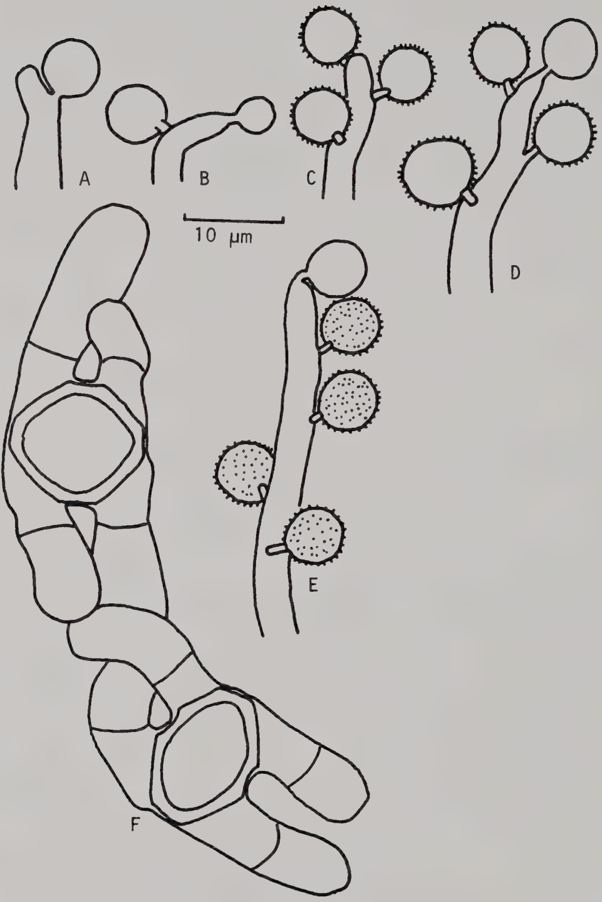


Fig. 1. ZYGNEMOMYCES ECHINULATUS Miura.

(A-E) Stages in sporophore development, showing acropetal maturation of the spores; (F) zygospores formed following scalariform conjugation. Redrawn from Miura (1973). Fig. 2E represents a portion of the iconotypus. Bar=10µm.

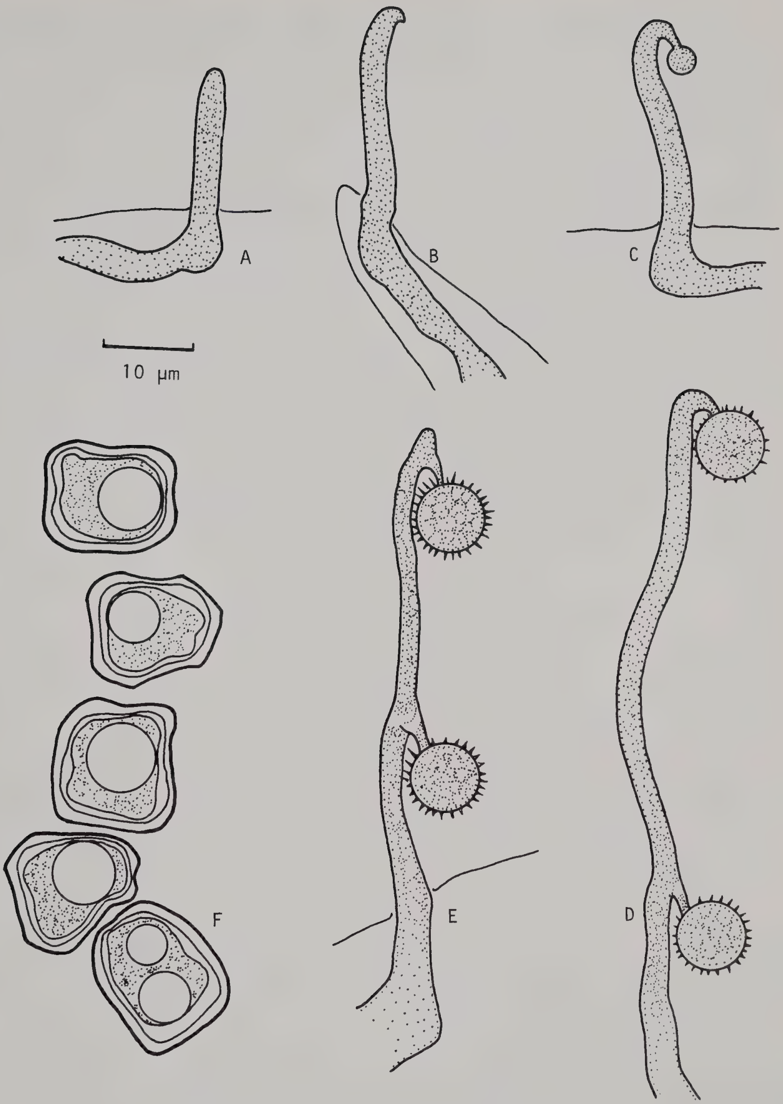


Fig. 2. ZYGNEMOMYCES PENDULATUS (McCulloch) Tucker.

(A-E) Stages in sporophore development, showing the apical hook that becomes the pedicel, and continued growth by sympodial proliferation; (D-E) mature echinulate spores, the pedicel making an acute angle with the sporophore base; (F) zygospores within the nematode. Drawn from type slide. Bar=10μm.

Zygnemomyces was established by Miura (1973) who distinguished *Z. echinulatus* from *Ballocephala* and *Meristacrum* by three characters: echinulate spores (though this is no longer valid with the discovery of *Ballocephala verrucospora* by Richards [1970]), spores borne on pedicels (and hence not discharged), and octangular zygospores formed by scalariform conjugation. The first two characters also are found in *Z. pendulatus*, and a careful reexamination of spore development has shown that both species have sympodially proliferating sporophores (Figs. 1 & 2). The two species can be distinguished on the basis of sporophore size (Table 4), spore number (Table 3), and orientation of the pedicel.

The three multispored genera: *Meristacrum*, *Ballocephala*, and *Zygnemomyces*, as here treated are coherent genera, and each is quite easily distinguished from the others. *Meristacrum*, with basipetally septate sporophores contrasts with the nonseptate sporophores of *Ballocephala* and *Zygnemomyces*. While spores develop acropetally in both of these genera, the manner in which the spores are formed and discharged (i.e., borne on propulsive sporiferous cells vs. pedicels formed from the sporophore apex) is significantly different.

MACROBIOTOPHTHORA Reukauf emend.,

Centralbl. Bakt. Parasit. Infekt. Abt. 1 63: 390. 1912.

Type species: *Macrobiotophthora vimariensis* Reukauf. Centralbl. Bakt. Parasit. Infekt. Abt. 1 63: 390. 1912.

Vegetative thallus developing internally within host, giving rise to external hyphae and sporophores on which single terminal spores are borne; spores obovate, flat based, forming secondary spores or germinating vegetatively; conjugation scalariform or lateral forming zygospores, resting spores absent, or producing chlamydospores.

This genus was established by Reukauf (1912) for *M. vimariensis*, a fungus which he found parasitizing *Hypsibius dujardini* (Doyère) (=*Macrobiotis lacustris* Duj.) living near a spring in Belvederer Parks in Weimar, Germany. This fungus produced hyphal bodies which digested the fat bodies of the tardigrade and then gave rise to a multitude of sterile aseptate hyphae which penetrated the cuticle. Primary spores were obovoid, uninucleate and were produced terminally. These spores either germinated directly or gave rise to secondary spores on slender sporophores. While no other fungi similar to *M. vimariensis* have been isolated from tardigrades, the following nematode parasite is sufficiently similar to warrant transfer to this genus.

Other species:

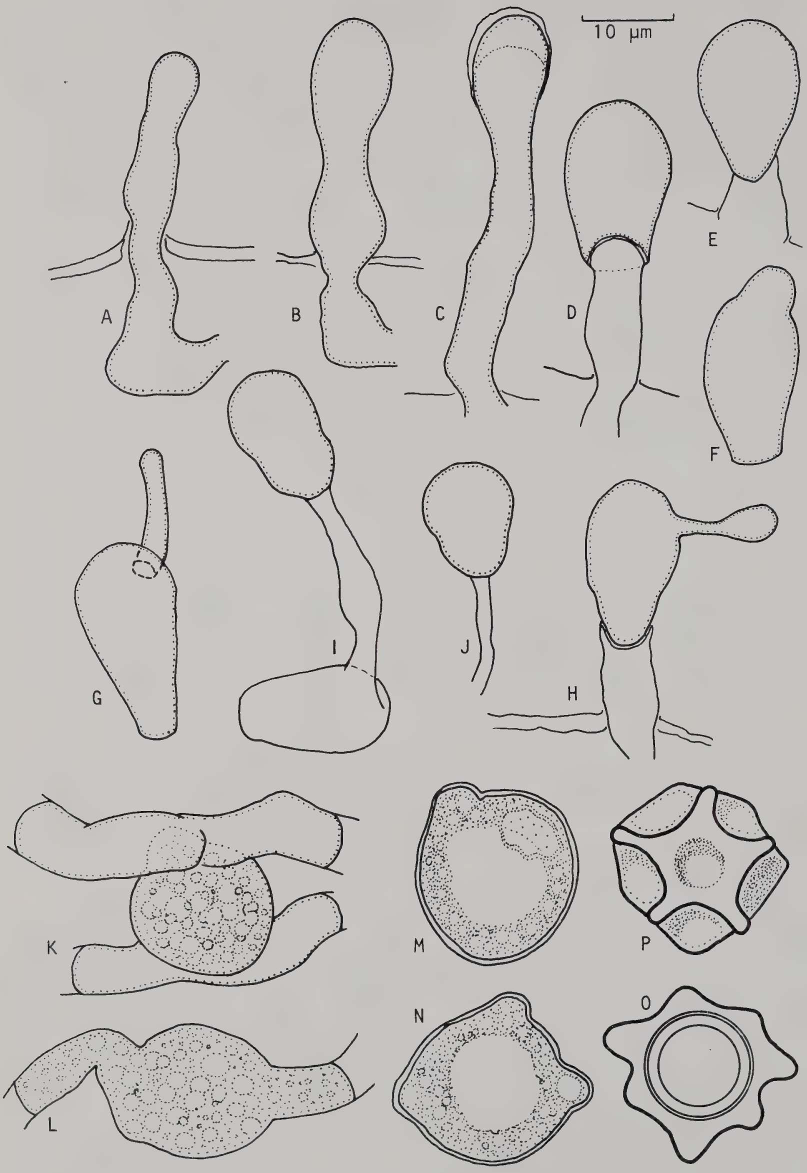
MACROBIOTOPHTHORA VERMICOLA (McCulloch), comb. nov.,
Basionym: Entomophthora vermicola McCulloch. Trans. Brit. Mycol. Soc. 68: 173. (Figs. 1-2). 1977.

Body of infested nematode filled with nonseptate hyphae, 5-7 µm in diameter, developing erect hyphae which penetrate the nematode cuticle; external hyphae hyaline, unsegmented, flexuous (40-) 110-160 x 3-6 µm; sporophores 27-50 x 6-8 µm, straight or bent at the point of emergence (110-120°), unbranched (branched according to McCulloch); primary spores terminal, obovoid, 16-22 x 9-14 µm (rarely to 30 x 16 µm), pleurinucleate and unitunicate, discharged at maturity, adhering to the cuticle of a passing nematode and initiating new infections; secondary spores obovoid medialy constricted, nonpapillate, 14.4-15.5 µm long, 9-13.3 µm in diameter narrowing at a neck to 7.4-8.9 µm; secondary sporophores 17-20 µm long, 3.5-4.5 µm at base, tapering to 1.8-2.2 µm at spore; zygospores 17-22 µm, dodecahedroid, faces centrally depressed with 4-6 edges.

Of the three type slides, only the one containing the nematode illustrated in McCulloch (1977: Fig. 1) remains intact (Figs. 3A-J). External hyphae are present, but these are not the morphologically modified cystidia found in species of Erynia (Remaudière and Hennebert 1980, Humber 1981). Figure 3C shows the appearance of several of the developing spores with a thin, hyaline outer wall layer separated from the spore wall proper, and the retraction of the cytoplasm from the spore apex. While the separated wall resembles the image seen in spores with bitunicate walls, these effects are probably due to the lactophenol mounting medium. The secondary spores are obovoid and medially constricted, with a distinct neck below a more globose region (Fig. 3H-J). A basal papilla is lacking making secondary spore discharge unlikely. The sporophores on which they are borne taper to a narrow point of attachment, but they are not the true capillary sporophores of other genera.

Macrobiotophthora vermicola was originally placed in Entomophthora, a genus to which it is no longer referable. Living material of this species obtained from E. Bernard, permitted additional characterization of the species, and the following observations are in conflict with the original description. The primary spores contain 4-9 Entomophthora-type nuclei and are forcibly discharged by papilla eversion. Secondary spores are medially constricted and passively detached. Dodecahedral zygospores are formed following scalariform or lateral conjugation.

Two Conidiobolus-like fungi reported from nematodes (Castaner 1968, Amin and Webster 1980) are probably species of Macrobiotophthora. However, nuclear morphology and number are unspecified, making placement of these two fungi provisional. The method of thallus and primary spore formation in all three nematophagous fungi is similar, but differences include the absence of zygospores (although these will probably be found), forcible discharge of secondary spores, production of microspores (?), and variation in


10 μm
A
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spore size (see Tables 2-5). Additional reports of parasites on terricolous animals may increase further the size of Macrobiotophthora by at least two, if not more species.

IV. FAMILIES OF THE ENTOMOPHTHORALES.

At present, the order is variously divided, with one family, Entomophthoraceae (Waterhouse 1973); two families, Entomophthoracee and Basidiobolaceae (Alexopoulos and Mims 1979, Benjamin 1979); or three families, Entomophthoraceae, Ancylistaceae, and Basidiobolaceae (Ubrizsy and Vörös 1966, Batko 1974). Although three characters: karyology, spore discharge mechanism, and conjuation might logically be used to delimit these families, only karyology results in a division consistent with current views of the order.

1. Separation of the genera on the basis of spore discharge method would result in four groups. The basic papilla-eversion method has been modified in Entomophthora to form a sporophore-cannon. The significance of this is reduced, since the secondary spores of E. muscae are still dispersed by the papilla-eversion method. Similarly, Basidiobolus has a vestigial spore papilla, although the propulsive force is provided by the rupture of a subspore swelling.

Less obvious is the origin of the Ballocephala discharge vesicle. The suggestion that the vesicle is homologous with the primary spore (Drechsler 1951), and gives rise directly to sessile secondary spores that (like capillispores) are not dispersed, is consistent with the basic developmental patterns of the Entomophthorales. It also should be noted that spore discharge was lost independently by Massospora and Zygnemomyces. From the above observations, it can be concluded that spore discharge mechanism cannot be used alone for family delimitation.

2. Details of gametangial conjugation and resting spore morphology are also possible criteria for family delimitation. Zygospore characteristics have proven to be useful and conservative within the other orders of the Zygomycotina (Benjamin 1979). The Basidiobolaceae, with its beaked gametangia, is distinct from all other members of the order. The tendency of Conidiobolus and Ancylistes to form zygospores in line with the unequal gametangia

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Fig. 3. MACROBIOTOPHTHORA VERMICOLA (McCulloch) Tucker.

(A-H) Spores and sporophores drawn from the type slide. (A-B) Development of primary sporophores; (C) sporophore with retracted cytoplasm and separated outer wall layer; (D) primary spore with distinct columella; (E) spore with everted papilla; (F) germinating primary spore; (G-J) development of secondary spores, (I-J) medially constricted obovoid secondary spores on tapering secondary sporophore. (K-P) Conjugation and zygospores from living culture. Scalariform (K) and lateral (L) conjugation; (M-N) developing zygospores; Mature zygospore in optical section (O) and surface aspect (P). Bar=10μm.

contrasts with the laterally budded zygospores of Entomophthora. Yet division of the order into families on this character alone is problematical due to the difficulties in interpreting zygospore development in many species, and the absence of conjugation in others. Until more research is done on Entomophthorales, the utility of zygospore characters will remain suspect.

3. Karyology is here regarded as the most useful character, and three distinct lines can be delimited within the Entomophthorales: Basidiobolus with large nuclei with central nucleoli; Entomophthora, Entomophaga, Erynia, Strongwellsea Batko & Weiser emend. Humber, Massospora, Completoria (Humber pers. comm.), and Macrobiotophthora have small, readily staining nuclei with heterochromatin but without a central nucleolus; and Ancylistes, Conidiobolus, Meristacrum, Ballocephala (?), and Zygnemomyces (?) have small, poorly staining nuclei with a central nucleolus. The elevation of these three groups to family status is not only consistent with the currently accepted segregation of the Basidiobolaceae, but also unites those genera which have similar spore discharge and zygospore characteristics and provides a logical framework for the perception of evolutionary trends within the Entomophthorales as a whole.

V. CONCLUDING REMARKS.

The taxonomic revisions proposed here are based upon the evaluation of basic morphological characteristics. Although important, the host organism is deemphasized at the generic level. While research in the Entomophthorales has been and probably will continue to be centered upon the parasites of insects, the nonentomogenous fungi must not be overlooked. It is hoped that as new reports of nonentomogenous fungi are forthcoming, they will include full descriptions of all aspects of nuclear morphology and number, method of spore discharge, sporophore architecture, zygospore development and morphology, and thallus characteristics. Only then will a fuller understanding of the order as a whole be obtained.

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KEY TO THE SPECIES OF NONENTOMOGENOUS ENTOMOPHTHORALES

1 . Sporophore producing one terminal spore..................... 2
1'. Sporophore producing several spores per sporophore.......... 7

2 . Spores pyriform.. 3
2'. Spores obovate... 6

3 . Nuclei staining readily, parasitic on fern prothalli ....*Completoria complens*
3'. Nuclei poorly staining, parasitic on desmid algae........... 4

4 . Zygosporangium with several protuberances; zygospore loose within the zygosporangium...........*Ancylistes pfeifferi*
4'. Zygosporangium smooth.. 5

5 . Host *Closterium* (Placoderm Desmid); primary spores 13-17.5 µm..........................*Ancylistes closterii*
5'. Host *Netrium* (Saccoderm); spores 16-25 µm....*Ancylistes netrii*

6 . Vegetative thallus consisting of hyphal bodies; parasitic on tardigrades.................*Macrobiotophthora vimariensis*
6'. Vegetative thallus septate-mycelial; parasitic on nematodes ....*Macrobiotophthora vermicola*

7 . Sporophores becoming transversly septate; spores developing basipetally.. 8
7'. Sporophores remaining nonseptate, or producing lateral, basally septate sporiferous cells; spores developing acropetally.. 9

8 . Spores pyriform; zygospores ovoid, punctate; 2° spores replicative...........................*Meristacrum milkoi*
8'. Spores obovate; azygospores spherical, walls undulate; 2° spores passively detached.......*Meristacrum asterospermum*

9 . Spores produced on basally septate sporiferous cells, the rupture of which discharges the spore................. 10
9'. Spores produced terminally on the sporophore axis.......... 12

10 . Sporiferous cells utriculate, as large as spore or larger; spores formed along entire sporophore axis............ 11
10'. Sporiferous cells not inflated, smaller than spore; spores clustered at the tip.............*Ballocephala pedicellata*

11 . Spores smooth, unornamented.........*Ballocephala sphaerospora*
11'. Spores verrucose....................*Ballocephala verrucospora*

12 . Sporophore apex straight, becoming transformed into a spore-bearing pedicel forming an acute angle with the distal end of the sporophore...........*Zygnemomyces echinulatus*
12'. Sporophore apex becoming hooked, transformed into a pedicel which forms an acute angle with the proximal end of the sporophore.......................*Zygnemomyces pendulatus*

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ERYNIA (ZYGOMYCETES: ENTOMOPHTHORALES): EMENDATION, SYNONYMY, AND TRANSFERS

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SUMMARY

The emended sense of *Erynia* Nowakowski (Entomophthorales: Entomophthoraceae) is limited to species having uninucleate, bitunicate primary conidia borne on (digitately and apically) branched conidiophores and forcibly discharged by the eversion of the basal papilla. This emendation specifically (1) rejects a separation of *Zoophthora* Batko from *Erynia* based on the presence of capilliconidia or any other criterion, (2) rejects any synonymy of *Strongwellsea* Batko & Weiser emend. Humber with *Erynia*, and (3) excludes from *Erynia* any species having conidia which are multinucleate, unitunicate, or borne on simple (or rarely or basally branched) conidiophores. *Zoophthora* Batko is rejected as a later synonym of *Erynia* Nowak., and the remaining species of *Zoophthora* not previously placed in *Erynia* are transferred. All recognized species of *Erynia* sensu Humber & Ben-Ze'ev are cited.

The recognition of two genera, *Zoophthora* Batko (1964a) and *Erynia* Nowakowski (1881), separated principally by the formation of capilliconidia (secondary conidia formed atop capillary conidiophores) by Remaudière and Hennebert (1980) has raised a problem in synonymies (Humber 1981a): If the type species of *Zoophthora*, *Z. radicans* (Brefeld) Batko (=

Entomophthora sphaerosperma Fres. sensu Thaxter 1888), and the type species of *Erynia*, *E. ovispora* (Nowakowski) Nowakowski, are accepted on any basis to be in distinct genera, then both of these generic names may stand. If, however, one accepts Batko's sense of *Zoophthora* for all species with uninucleate, bitunicate conidia borne on branched conidiophores (Batko 1964a-b, 1966a-b, 1974; Humber 1981a-b, 1982; Ben-Ze'ev and Kenneth 1981a-b, 1982a-b), then both of these species must be in the same genus. Further, the International Code of Botanical Nomenclature (ICBN) requires that Batko should have adopted the older generic name, *Erynia*, rather than propose a new name for this large group of species.

Humber (1981a-b; 1982), Ben-Ze'ev (1980), and Ben-Ze'ev and Kenneth (1981a-b, 1982a-b) find no basis for the separate and simultaneous usage of *Zoophthora* and *Erynia* espoused by Remaudière and Hennebert (1980) and Remaudière and Keller (1980). Among the possible resolutions of this synonymy, the only one that is both in accord with the ICBN and the prior transfer of most *Zoophthora* species to *Erynia* (Remaudière and Hennebert 1980; Humber 1981a-b) is now to take up *Erynia* Nowakowski as the correct name of the genus which includes *Entomophthora radicans* Brefeld. Accordingly, we present an emended circumscription for *Erynia*, and regard *Zoophthora* to be a younger synonym.

ERYNIA Nowakowski emend. Humber & Ben-Ze'ev, emend. nov.

≡ *Erynia* Nowakowski, 1881, *Dzienn. III Zjazdu Lek. Przyr. Polak. Kraków., Sekc. Bot. 6,* 67-68.

= *Zoophthora* Batko, 1964, *Bull. Acad. Polon. Sci. Sér. Sci. Biol. 12,* 323.

VEGETATIVE STRUCTURES usually hyphal bodies or mycelium, but exact form depends upon stage of development. NUCLEI easily observed, 4.5-15 µm diameter; without a prominent central nucleolus; filled with conspicuous heterochromatic threads or granules. CONIDIOPHORES apically branched, forming a (usually digitate) cluster of conidiogenous cells; each branch basally septate, each conidiogenous cell usually uninucleate, producing a single apical conidium; some conidiophores unbranched, producing a single terminal conidiogenous cell and one conidium. PRIMARY CONIDIA uninucleate, bitunicate (with a separable outer wall layer except over the basal papilla); shape variable but usually ovoid, clavate, turbinate, or elongate, radially symmetrical or curved; papilla centered on spore axis or displaced laterally; forcibly discharged by eversion of the papilla against the conidiophore. SECONDARY CONIDIA more or less similar to primary conidia (or with short radiate arms), formed singly on a short conidiophore arising from a primary conidium and forcibly discharged by eversion of the papilla or else amygdaliform to elongate, clavate, falcate, or lanceolate, usually curved, and borne on an extended, thin capillary conidiophore arising from a primary or secondary conidium. RESTING SPORES usually globose with two thickened wall layers; epispore colorless or variously colored, smooth or variously ornamented; budded laterally or terminally from parental hyphal body whether as zygospores or azygospores. RHIZOIDS present in most species, either (1) hypha-like, simple or branched, solitary or aggregated into pseudorhizomorphs, terminating in more or less branched (but only rarely discoid) holdfast of (2) stout, unbranched, solitary or loosely fasciculate (but not aggregated in pseudorhizomorphs), terminating in a richly branched discoid or irregularly expanded holdfast; rhizoids may not form when resting spores are produced. CYSTIDIA absent in most species; simple, usually aseptate, spear-like, extending slightly above level of conidiophores or else thick and columnar, aseptate, usually branching apically, extending far beyond level of conidiophores; cystidia usually absent when resting spores are formed in the host.

TYPE SPECIES: *Erynia ovispora* (Nowakowski) Nowakowski, 1881, *Dzienn. III Zjazdu Lek. Przyr. Polak. Kraków., Sekc. Bot. 6*, 67-68. Basionym: *Entomophthora ovispora* Nowakowski, 1877, *Bot. Zeitg. (Leipzig) 35*, 20.

This emendation rejects *Zoophthora* as a separate genus for species forming passively detached secondary capilliconidia as advocated by Remaudière and Hennebert (1980). It also rejects a definition of *Erynia* based on conidial morphology (Remaudière and Hennebert 1980; Remaudière and Keller 1980), thereby excluding *Erynia caroliniana* (Thax.) Rem. & Henneb. (with unitunicate, plurinucleate conidia on simple conidiophores) and restoring *Strongwellsea* Batko & Weiser emend. Humber (with bitunicate, uninucleate conidia on unvaryingly simple conidiophores; *cf.* Remaudière and Keller 1980, Humber 1981a, 1982). This emendation also acknowledges the formation of multiradiate secondary conidia by some riparian species (Descals et al. 1981).

The formal adoption of *Erynia* as the nomenclaturally correct name for the genus circumscribed above requires the transfer of all remaining names placed in *Zoophthora* but not yet formally acknowledged as species of *Erynia.*

ERYNIA APHIDIS (Hoffmann in Fresenius) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Entomophthora aphidis* Hoffmann in Fresenius, 1856, *Abhandl. Senckenberg. naturf. Ges. 2:* 208 emend. Remaudière & Hennebert, 1980, *Mycotaxon 11:* 290, NON *Entomophthora aphidis* Hoffm. in Fres. sensu Thaxter, 1888, *Mem. Boston Soc. Nat. Hist. 4:* 175.

ERYNIA CANADENSIS (MacLeod, Tyrrell, & Soper) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Entomophthora canadensis* MacLeod, Tyrrell, & Soper, 1979, *Canad. J. Bot. 57:* 2664.

ERYNIA CRASSITUNICATA (Keller) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Zoophthora crassitunicata* Keller, 1980, *Sydowia Ann. Mycol., Ser. II, 33:* 170.

ERYNIA COLEOPTERORUM (Petch) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Entomophthora coleopterorum* Petch, 1932, *Trans. Brit. Mycol. Soc. 17:* 172.

ERYNIA CRUSTOSA (MacLeod & Tyrrell) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Entomophthora crustosa* MacLeod & Tyrrell, 1979, *Canad. Entomol. 111:* 1138.

ERYNIA ELATERIDIPHAGA (Turian) Humber, Ben-Ze'ev, & Kenneth, comb. nov. BASIONYM: *Entomophthora elateridiphaga* Turian, 1978, *Mitt. Schweiz. Entomol. Ges. 51:* 398.

ERYNIA GEOMETRALIS (Thaxter) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Empusa (Entomophthora) geometralis* Thaxter, 1888, *Mem. Boston Soc. Nat. Hist. 4:* 170.

ERYNIA HENRICI (Molliard) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Entomophthora henrici* Molliard, 1918, *Compt. Rend. Hebd. Séances Acad. Sci. Paris 167:* 958.

ERYNIA JACZEWSKII (Zaprometov in Jaczewski & Jaczewski) Humber, comb. nov. BASIONYM: *Tarichium jaczewskii* Zaprometov in Jaczewski & Jaczewski, 1931, *Opredelitel gribov 1:* 225.

ERYNIA LANCEOLATA (Keller) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Zoophthora lanceolata* Keller, 1980, *Sydowia Ann. Mycol., Ser. II, 33:* 133.

ERYNIA NEBRIAE (Raunkiaer) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Entomophthora nebriae* Raunkiaer, 1892, *Bot. Tidsskr. 18:* 108-111.

ERYNIA OCCIDENTALIS (Thaxter) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Empusa (Entomophthora) occidentalis* Thaxter, 1888, *Mem. Boston Soc. Nat. Hist. 4:* 171.

ERYNIA ORIENTALIS (Ben-Ze'ev & Kenneth) Humber, Ben-Ze'ev, & Kenneth, comb. nov. BASIONYM: *Zoophthora orientalis* Ben-Ze'ev & Kenneth, 1981, *Phytoparasitica 9:* 35.

ERYNIA PHALLOIDES (Batko) Humber & Ben-Ze'ev, comb. nov. BASIONYM: *Zoophthora phalloides* Batko, 1966, *Acta Mycol. 2:* 7.

ERYNIA PHYTONOMI (Arthur) Humber, Ben-Ze'ev, & Kenneth, comb. nov. BASIONYM: *Entomophthora phytonomi* Arthur, 1886, *Bot. Gaz. (Crawfordsville) 11:* 14.

ERYNIA RADICANS (Brefeld) Humber, Ben-Ze'ev, & Kenneth, comb. nov. BASIONYM: *Entomophthora radicans* Brefeld, 1870, *Bot. Zeitg. (Leipzig) 28:* 186.

Entomophthora coleopterorum Petch (1932) is included in the above list because of the conjunction of long, narrowly oval conidia (32-44 x 8-14 μm), two fascicles of stout rhizoids emerging from specific points on the ventral thorax, and cystidia (Petch 1944). This set of characters occurring together is known only from *Erynia* species although it must still be determined that *E. coleopterorum* has uninucleate, bitunicate conidia and branched conidiophores. Petch (1944) regarded this species to be a probable synonym of *Entomophthora carpentieri* Giard (1888) whose description was based wholly on the unique mode of rhizoidal attachment of affected elaterid beetles. Turian (1957) identified as *E. carpentieri* a fungus he found on beetles which died head-down and were attached to the plant by two fascicles of rhizoids; he claimed this fungus produced uninucleate, globose conidia. Humber (1981a) raised doubts about Turian's interpretation and discussed the possible synonymy of *E. carpentieri* and *E. coleopterorum.* Until any extant material of these collections can be re-examined, there is no doubt that the best characterized of these collections is *E. coleopterorum*, and that this species is more certainly a species of *Erynia* than of any other entomophthoralean genus.

Entomophthora henrici Molliard (1918), which was described from mosquitoes (*Culex pipiens*), is accepted here as an *Erynia* species by virtue of its much branched conidiophores, presence of cystidia (which Molliard stated were also produced in culture), and of rhizoids with discoid or irregularly ramified holdfasts. It remains to be established whether the conidia of this species are uninucleate and bitunicate as may be predicted from this constellation of other characters. *Erynia henrici* resembles *E. ovispora*, but insufficient information about the morphological plasticity of either species currently exists to support the proposition by Waterhouse (1975) of their synonymy.

Entomophthora nebriae Raunkiaer (1892), which attacks carabid beetles (*Nebria brevicolis*), has elongate conidia (28.0-37.0 x 10.0-13.0 μm) borne on richly branched conidiophores. Rhizoids are present, but their morphology is not described. No secondary conidial forms or cystidia are mentioned by Raunkiaer (1892). The resting spores of this species are formed outside of the host body, and are spherical, 36-50 μm in diameter, with a pale brown, smooth, and rather thin wall. Batko (1966b) regarded this species to belong in *Zoophthora* subg. *Zoophthora.*

Zoophthora jaczewskii (Zaprometov in Jaczewski & Jaczewski) Batko (1964b) was not discussed by Remaudière and colleagues in their revision of entomophthoralean taxonomy. We have been unable to obtain the literature to confirm either the nomenclatural validity of *Tarichium jaczewskii* Zaprometov in Jaczewski & Jaczewski (1931; see also MacLeod and Müller-Kögler 1970) or the appropriateness of Batko's acceptance of *Entomophthora zabrii* Rozsypal (1951; an invalidly published *nomen nudum*) as the conidial state of *T. jaczewskii*. One of the present authors (RAH) feels that it is not unreasonable to accept both Batko's acknowledgement of *T. jaczewskii* to be validly published and of his synonymization of *E. zabrii* with this species.

Those species previously described as or transferred to *Erynia* and accepted according to the above emendation include the following:

Erynia americana (Thaxter) Remaudière & Hennebert (1980)
Erynia aquatica (Anderson & Ringo ex Anderson & Anagnostakis) Humber (1981a) non *Erynia aquatica* (Anderson & Ringo) Remaudière & Hennebert (1980)
Erynia blunkii (Lakon ex Zimmermann) Remaudière & Hennebert (1980)
Erynia brahminae (Bose & Mehta) Remaudière & Hennebert (1980) (possibly synonymous with *Erynia echinospora*)
Erynia bullata Thaxter & MacLeod in Humber (1981b) non *Erynia bullata* (Thaxter in Povah) Remaudière & Hennebert (1980)
Erynia calliphorae (Giard) Remaudière & Hennebert (1980)
Erynia conica (Nowakowski) Remaudière & Hennebert (1980)
Erynia creatonoti Yen in Humber (1981b) non *Erynia creatonoti* (Yen) Remaudière & Hennebert (1980)
Erynia curvispora (Nowakowski) Nowakowski (1881)
Erynia delpiniana (Cavara) Humber (1981a)
Erynia delphacis (Hori) Humber (1981a)
Erynia dipterigena (Thaxter) Remaudière & Hennebert (1980)
Erynia echinospora (Thaxter) Remaudière & Hennebert (1980)
Erynia erinacea (Ben-Ze'ev & Kenneth) Remaudière & Hennebert (1980)
Erynia formicae Humber & Bałazy in Humber (1981b)
Erynia gloeospora (Vuillemin) Remaudière & Hennebert (1980)
Erynia gracilis (Thaxter) Remaudière & Hennebert (1980)
Erynia montana (Thaxter) Remaudière & Hennebert (1980)
Erynia myrmecophaga Turian & Wuest in Humber (1981b) non *Erynia myrmecophaga* (Turian & Wuest) Remaudière & Hennebert (1980)
Erynia neoaphidis Remaudière & Hennebert (1980) [= *Entomophthora aphidis* Hoffmann in Fresenius sensu Thaxter (1888)]
Erynia nouryi Remaudière & Hennebert (1980) [= *Entomophthora*

exitialis Hall & Dunn sensu Gustafsson (1965)]
Erynia ovispora (Nowakowski) Nowakowski (1881)
Erynia phalangicida (Lagerheim) Remaudière & Hennebert (1980)
Erynia rhizospora (Thaxter) Remaudière & Hennebert (1980)
Erynia sepulchralis (Thaxter) Remaudière & Hennebert (1980)
Erynia variabilis (Thaxter) Remaudière & Hennebert (1980)
Erynia virescens (Thaxter) Remaudière & Hennebert (1980)
Erynia vomitoriae (Rozsypal) Remaudière & Hennebert (1980)

Doubtful or excluded species:

Erynia caroliniana (Thaxter) Remaudière & Hennebert (1980) ≡ *Entomophthora caroliniana* (Thaxter) Keller, 1978, *Sydowia Ann. Mycol., Ser. II, 31:* 88 ≡ *Empusa caroliniana* Thaxter, 1888, *Mem. Boston Soc. Nat. Hist. 4:* 167.
Erynia castrans (Batko & Weiser) Remaudière & Keller (1980) ≡ *Strongwellsea castrans* Batko & Weiser, 1965, *J. Invert. Pathol. 14:* 463 emend. Humber, 1976, *Mycologia 68:* 1056.
Erynia magna (Humber) Remaudière & Keller (1980) ≡ *Strongwellsea magna* Humber, 1976, *Mycologia 68:* 1057.
Zoophthora exitialis (Hall & Dunn) Batko, 1966, *Bull. Polon. Acad. Sci., Sér. Sci. Biol. 12:* 405 ≡ *Entomophthora exitialis* Hall & Dunn, 1957, *Hilgardia 27:* 163.
Zoophthora ferruginea (Phillips in Houghton & Phillips) Batko, 1966, *Acta Mycol. 2:* 19 ≡ *Entomophthora ferruginea* Phillips in Houghton & Phillips, 1886, *Ann. Mag. Nat. Hist. Ser. 5, 18:* 6.
Zoophthora forficulae (Giard) Batko, 1964, *Bull. Polon. Acad. Sci., Sér. Sci. Biol. 12:* 404 ≡ *Empusa forficulae* (Giard) Petch, 1944, *Trans. Brit. Mycol. Soc. 27:* 87 ≡ *Entomophthora forficulae* Giard, 1889, *Bull. Sci. France Belgique 20:* 211.

Empusa caroliniana and the two species of *Strongwellsea* are excluded from *Erynia* for reasons mentioned above and discussed extensively by Humber (1981a, 1982).

Remaudière and Hennebert (1980) provide strong reasons to regard both *Entomophthora exitialis* Hall & Dunn (1957) and *Entomophthora ferruginea* Phillips in Houghton and Phillips (1886) as *nomina confusa*; we agree with and accept these determinations. It is impossible to know exactly what fungus is described or illustrated by Hall and Dunn (1957); this situation is not eased by the fact that no type was declared for *E. exitialis* (nor did the ICBN require typification until the year after the publication of this species) or that the cultures deposited by the authors of this taxon in various major culture collections are found to be either *Conidiobolus* *thromboides* Drechsler (= *Entomophthora virulenta* Hall & Dunn) or *Erynia radicans* (see Remaudière and Hennebert 1980). The fungus regarded to be *E. exitialis* by Gustafsson (1965) was redescribed by Remaudière and Hennebert (1980) as *Erynia nouryi*. Similarly, the real identity of *Entomophthora ferruginea* remains indeterminable in view of the three separate senses in which this name has been applied (see Remaudière and Hennebert 1980).

Batko (1964b) offered no explanation for his assignment of *Entomophthora forficulae* Giard to *Zoophthora*. Neither Remaudière and Hennebert (1980) nor Remaudière and Keller (1980) mentioned this species in their treatments of *Zoophthora* and *Erynia*, possibly because Giard (1889) mentioned no secondary conidia (the character used by Remaudière et al. to separate these two genera), and possibly because of the uncertainty which surrounds the identity of this fungus. The conidia of Giard's species are 20 x 6 μm up to 25 x 8 μm, with a length/width ratio of ≥ 3; the conidia in the only other collections attributed to this species are 18-21 x 8-10 μm (Rostrup 1893) and 20-30 x 15-18 μm (Petch 1944), with L/W ratios of ≤ 2. Giard, who did not recognize the widely used distinction between *Empusa* (with simple conidiophores) and *Entomophthora* (with branched conidiophores), noted the conidiophores of *Entomophthora forficulae* to be only infrequently branched ("peu ramifiés"); those of the fungi reported by Rostrup and Petch could not have been prominently or digitately branched since Petch (1944) reassigned this species to *Empusa*. Rhizoids were not noted in any of these three collections (and note that Batko 1964a required rhizoids to be present in species of *Zoophthora*!). Despite the fact that L/W ratios of 3 or more are known only from *Erynia* species (with the sole exception of Balazy's undescribed species noted by Humber 1981a), the absence of information regarding the wall structure and nuclear number of the conidia, and of the actual nature of the conidiophores suggests that no definitive generic assignment for *Entomophthora forficulae* is advisable in the absence of other characters so frequently noted in species of *Erynia*. It seems doubtful that the collections of fungi by Rostrup (1893) and Petch (1944) are conspecific with *E. forficulae* Giard; the true identity of each of these fungi remains to be established by re-examination of any existing herbarium specimens.

At least two aspects of this emendation of *Erynia* deserve further comment. It is important to re-emphasize that this nomenclaturally required change from *Zoophthora* to *Erynia* has also necessitated the shift of the type species from the very common *Erynia radicans* (= *Entomophthora sphaerosperma* Fres. sensu Thaxter) (see Batko 1964a; Remaudière and Hennebert 1980) to the less well known *Erynia ovispora*. Regardless of its nomenclator, the fungus which is still most widely known as *Entomophthora sphaerosperma* has served as the type for a genus distinguished primarily by the presence of rhizoids and branched conidiophores ever since Nowakowski (1883) affirmed a real taxonomic difference between *Empusa* and *Entomophthora*.

Entomophthora aphidis Hoffm. in Fres. was originally described only from its brown, roughened resting spores; the conidial state of this species was not found or described by Hoffmann. In his influential monograph, Thaxter (1888) applied the name *Empusa (Entomophthora) aphidis* to an exceptionally common fungal pathogen of aphids which produces conidia and whose resting spores may be assumed to exist but have never been found. Remaudière and Hennebert (1980) were successful in rediscovering Hoffmann's fungus and demonstrated unequivocally that Thaxter had misapplied Hoffmann's specific name: The conidia of *E. aphidis* Hoffm. are elongate-fusoid and produce secondary amygdaliform capilliconidia atop capillary conidiophores. The presence of capilliconidia in *E. aphidis* but not in Thaxter's fungus was used by Remaudière and Hennebert to place these two fungi into separate genera as *Zoophthora aphidis* (Hoffm. in Fres.) Batko and *Erynia neoaphidis* Rem. & Henneb. (the new name provided for Thaxter's misapplied sense of *E. aphidis*). The emended sense of *Erynia* provided here places both of these species together in the same genus. It will be especially important, then, for students of these fungi not to confuse these two similar specific names and to be certain that they do not apply the name *Erynia aphidis* (a very uncommon fungus with a seemingly narrow host range and localized distribution) when the fungus they refer to is actually *Erynia neoaphidis* (a very common species with a wide host range and occurring in most parts of the world).

In addition to the species of *Erynia* discussed above, we are aware of two additional new species awaiting publication: Kramer (1981) is proposing a new species of *Erynia* from snipe flies (Diptera: Rhagionidae). Ben-Ze'ev and Kenneth (1981b) are proposing a new species of *Zoophthora* which affects froghoppers (Homoptera: Cercopidae); this species will have to be transferred to *Erynia* after its formal publication.

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REVUE DES LIVRES

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THE COELOMYCETES, Fungi imperfecti with pycnidia, acervuli and stromata, by Brian SUTTON, 696 p., 397 fig., 8°, hard cover, 1980. Commonwealth Mycological Institute publication, Commonwealth Agricultural Bureaux, Farnham, Slough SL2 3BN, England. Price UK £ 28.00, abroad £ 33.60.

The Coelomycetes by Sutton is the first comprehensive and modern contribution on that important wide spread group of fungi. After numerous publications on the Coelomycetes, including seven issues in the CMI Mycological Papers and the fundamental and synthetic chapter on Coelomycetes in *The Fungi IVA* (1973), we are really thankful for such a fine monograph covering 375 genera and 750 species.

The inestimable progress realized by Dr Sutton in the taxonomy of these fungi is the recognition of conidiogenesis as a basic taxonomical criterion to be used at the level of classes and orders, the conidiomatal structure (pycnidia, acervuli, sporodochia, etc.) and morphology being useful as a secondary criterion at the suborder level or lower. Although, in that concept of the taxonomy of conidial fungi, Hyphomycetes and Coelomycetes would ideally be and are close to being unified and classified according to the conidiogenesis, the conidioma from the pycnidium to the obsolete exposed conidial cell representing a *continuum*, the author still uses the term *Coelomycete* here for the practical reason of delimiting a workable field. Accepting the major modes of conidiogenesis as defined at the 1st Kananaskis Conference (1969), Sutton proposes two classes in the Deuteromycotina, the Thallodeuteromycetes and the Blastodeuteromycetes, and five orders, the Thallales, Enterothallales, Blastales, Phialidales and Tretales, instead of the traditional Sphaeropsidales, Melanconiales and Moniliales. The structure of the conidioma delimits eventually the suborders, f.i., in the Blastales, the Blastohyphineae (blastic Moniliales), the Blastopycnidineae (blastic pycnidial), the Blastopycnothyrineae (blastic Pycnothyriales) and the Blastostromatineae (blastic Melanconiales).

Notice that two orders, the Enterothallales and the Tretales, are not reprensented amongst the coelomycetous fungi so far but in the Hyphomycetes only. The Coelomycetes traditionally classified in the Pycnothyriales and now representing the Thallopycnothyrineae, the Blastopycnothyrineae and the Phialopycnothyrineae, are not treated for the simple reason that almost no information on their conidiogenesis is available.

Sutton discuss the hypothesis of Morgan-Jones, Nag-Raj and Kendrick (1972) that a disinction might exist between an annellidic conidiogenous cell and percurrently proliferating phialide but is not convinced . He prefers to base the distinction between annellidic and phialidic percurrently proliferating conidiogenous cell on the single or repetitive conidium production by each of the successive cells. There is the reason why some fungi having conidiogenous cells looking like annellides are classified as repetitively proliferating phialidic fungi.

In regard of the amount of new information to be included, the author chose with reason to avoid any already published data and to refer to good descriptions, illustrations or comments published elsewhere when possible. Quite a number of genera are therefore not illustrated. But it would have been of great help to the users to reproduce, at least, an illustration of those genera, to give at once a full picture of the group.The text of the book is concise but clear. The paper, rather thin but of good quality and flexible, makes the size of the book reasonable and its manipulation easy. The book is completed with adequate indices and a glossary.

There is no need to say that the Coelomycetes are economically important plant pathogens and material deteriogens. Not only should any mycologist welcome this major contribution to the systematics of fungi, so also should any plant pathologist, forest manager or microbiologist concerned with soil biology or material degradation be aware of it.

Furthermore, taxonomists will appreciate being stimulated in their investigations by an author who, at almost every page of his book, points out some ways of progress.

A REVISION OF CHRYSOSPORIUM AND ALLIED GENERA, by C.A.N. van OORSHOT, Studies in Mycology n° 20, 90 p., 36 fig., 3 pl., 8°, paper cover, 1980. CBS Publication, Baarn Nederland. Price HFL 25.-.

Chrysosporium Corda and the related genera *Myceliophthora, Emmonsia, Zymonema, Trichosporiella, Blastomyces, Glenosporella and Geomyces* are revised, including 38 species and varieties. The redescribed anamorphs have either thallic or blastic conidiation and rhexolytic dehiscence. Teleomorphs belong to the Gymnoascaceae, Onygenaceae, Ascosphaeraceae and Sordariaceae. The genus *Chrysosporium* Corda is quite an homogenous grouping now, *Sporotrichum pannorum* Link having a distinct position in *Geomyces.*

COELOMYCETES. VII. STEGONSPORIUM, by K.T. Van WARMELO and B.C. SUTTON, Mycological Papers n° 145, 46 p., 13 pl., 8°, paper cover, 1981. Commonwealth Mycological Institute, Kew Surrey, England. CAB Publication. Price £ 3.00.

The original spelling *Stegonsporium* from Corda in Opiz 1926 is accepted instead of Fries's spelling *Stegonosporium* 1849. Two species are maintained, *S. pyriforme* and *S. acerinum.* Sixty five species are excluded or questioned. The excluded species belong to *Stigmina, Myxocyclus, Coryneum, Camarosporium, Trimmatostoma, Dictyodesmium, Neohendersonia* and *Camaropellum,* with five new combinations. Two new genera, *Stegonsporiopsis* and *Kaleidosporium* are proposed with two new combinations. *Stegonsporium* produces annellidic conidiophores with dictyoseptate conidia amongst filiform paraphyses.

CONTRIBUTION TOWARDS A RATIONAL ARRANGEMENT OF THE CLATHRACEAE, by D.M. DRING, 96 p., 27 fig., 8°, paper cover, 1981, reprinted from Kew Bulletin, 35(1), 1980. Royal Botanic Gardens, Kew, England. Price £ 5.00.

These are the conclusions of a long-term interest and research in the Clathraceae by the late Dr. Dring († 1978) and of his personal observations in West Africa. It has been fortunate that the unfinished manuscript could be completed from the author's large collection of notes and drawings. Dring recognized 8 genera, *Azeroë, Blumenavia, Clathrus, Colus, Ideodictyon, Laternea, Lysurus and Pseudocolus,* and 36 species. These are fully described and illustrated, with synonymies and references to other valuable illustrations. The specimens examined are all cited, demonstrating the often restricted geographical distribution. The genus *Clathrus,* with 16 species, is the largest one and appears to the author as the ancester of a diversifying evolution. All the species of the Clathraceae, the exception of *Clathrus ruber* and *C. hirudinosus* represented in Europe, West Asia and North Africa, are known from the other parts of the world and many are from tropical areas.

THE GENERA OF FUNGI SPORULATING IN PURE CULTURE, by J.A. von ARX, third edition, 424 p., 99 pl., 8°, kard cover, 1981. J. Cramer, Fl 9490 Vaduz, Lichtenstein. Price DM 120.-, for subscribers 100.-.

This third edition of Dr von Arx's book is a fully revised and expanded version of the previous ones. The classification of the fungi has been emended according to recent advances. The Dothideales include the Myriangiales, Dothiorales and Pseudosphaeriales. The Pezizales include the Tuberales. The Tilletiales are reintroduced. The Ustomycetes (Ustilaginales, Exobasidiales, Taphrinales, Sporobolomycetales and basidiomycetous yeasts) are distinguished from the Endomycetales on morphological grounds and wall composition. Basidiomycetes are not otherwise treated. All together 853 genera are accepted, of which only 370 are given an illustration, one third of these illustrations being new and based on recent studies. About 50 genera, some of them being recently described, are reduced into synonymy. Some genera rejected in recent years are reintroduced, e.g. *Endomycopsella, Karakulina* and *Bipolaris.* Illustrations and dichotomous keys result from studies of the fungi in pure culture, independent of their natural substrate. Keys have been adjusted to updated terminology. The 1100 literature titles include the most recent ones published in 1980. This edition, certainly like the previous ones, will be appreciated by those who have to identify fungi from sporulating cultures.

MARINE MYCOLOGY, The Higher Fungi, par Jan KOHLMEYER et Erika KOHLMEYER, xii + 690 p., 127 fig., 8°, relié toilé, 1979. Academic Press, N.Y. Price US $ 71.50.

149 Ascomycètes, 4 Basidiomycètes, 56 Deuteromycètes filamenteux et 177 levures sont les champignons supérieurs récoltés à ce jour près de et dans la mer. Des 209 espèces filamenteuses rencontrées, 191 sont spécifiques au milieu marin. C'est dire qu'un ouvrage intitulé *Marine Mycology* ne saurait être de pure taxonomie sans aussi considérer l'écologie. C'est cette alliance qu'ont fort bien réussie les deux auteurs. Après un exposé des méthodes (chap. 2) l'écologie des champignons côtiers et marins met en évidence les relations champignon-substrat chez les espèces de pleine eau, d'estuaires, de sables, des écumes, des marais salés, des algues , des lichens, des mangroves et des débris animaux et végétaux (chap. 3-19 et 21). Dans les chapitres touchant la taxonomie (chap. 20, 22-28; 421 p.) les auteurs proposent d'abord des clés dichotomiques basées sur la morphologie sporale ou conidienne et finement illustrées par Erika Kohlmeyer. Le principal chapitre 26 comporte la description taxonomique des 209 champignons filamenteux, avec synonymie, photographies et bibliographie. Une nouvelle espèce et 7 combinaisons sont proposées. 49 rejections de noms douteux ou invalides sont énoncées.

Dans le dernier chapitre, les levures sont répertoriées, sans description mais avec indication de leur habitat. Près de 1400 références bibliographiques complètent l'ouvrage. En mycologues avertis, les auteurs témoignent dans ce livre d'un sens aigu du détail et une manière esthétique de le mettre en valeur. Ce livre est une "somme" de ce domaine particulier de la mycologie. Sa qualité suscite l'admiration.

MICROBIAL POLYSACCHARIDES AND POLYSACCHARIDASES, par R.C.W. BERKELEY, G.W. GOODWAY and D.C. ELLWOOD édit., Publication de la Society for general Microbiology, xvi + 479 p., ill., 8°, relié, 1979. Academic Press, N.Y. Prix US $ 47.00.

Ce livre est la synthèse de deux symposiums tenus à Aberdeen en 1978, l'un sur *The microbial extracellular Polysaccharides* du Groupe pour l'étude des surfaces et membranes de la Cellule microbienne, l'autre sur *The microbial Degradation of Polysaccharides* de la Society for general Microbiology.

Sans doute, cet ouvrage sort du champ habituel de la mycologie. Cependant la composition différente des parois des champignons suivant leur classe taxonomique est une raison de considérer cet ouvrage de portée aussi fondamentale qu'appliquée. La détection, l'analyse et la production de polysaccharides et des enzymes qui les dégradent sont les objectifs d'une recherche de plus en plus active. Ce sont surtout les polysaccharides extracellulaires, comme le pullulan de l'*Aureobasidium pullulans,* qui retiennent l'attention. La paroi fongique est donc un organe essentiel. Sa composition, sa structure microscopique fine, sa perméabilité, la structure biochimique, l'activité et la solubilité de ses polysaccharides sont autant d'aspects traités dans ce livre. La paroi se détruit autant qu'elle se construit. Les polysaccharidases produites par les champignons eux-mêmes ou les bactéries associées agissent au niveau de la paroi fongique et dans le milieu, transformant les polysaccharides en nutrients recupérables. Ainsi les cellulases, chitinases, amylases, glucanases, pullulanases des champignons ne sont pas les moins connues.
Ce livre s'adresse non seulement au microbiologiste et biochimiste industriel, mais aussi le mycologue curieux de la nature exacte des champignons.

STEROLOGICAL METHODS. VOL. I. PRACTICAL METHODS FOR BIOLOGICAL MORPHOMETRY, par E.R. WEIBEL, 515 p., ill., 8°, relié toilé, 1979. Academic Press. Price US $ 66.50.

La première approche d'un être vivant est d'abord d'en saisir la forme. Au travers du microscope, où le relief disparaît, la forme est celle d'une image, d'un profil, d'une section. Le microscopiste, le biologiste, le mycologue traduit la vision de la forme (morphoscopie) en un tracé d'abord (morphographie), en une description ensuite (morphologie), en une mesure enfin (morphométrie). La promotion récente de la taxonomie numérique accentue la nécessité d'une morphométrie méthodique et traduisible en termes de réalité. La recherche de méthodes morphométriques valables est le but de la stéréologie. Ces méthodes sont mathématiques et visent à relier les paramètres tridimensionnels d'une structure spatiale aux mesures bidimensionnelles des sections de cette structure. Inversément, elles fournissent la réponse à la question: comment interpréter l'image vue au microscope comme expression de la réalité spatiale.
L'auteur ne traite pas des fondements mathématiques des méthodes, les réservant au volume II. Le livre est donc d'un niveau mathématique accessible à qui possède des notions de mathématique moderne. Par voie d'exemples, de photos et de graphiques, l'auteur explique les méthodes d'échantillonage des structures à mesurer et la réalisation de mesures

qui ne faussent pas la réalité. Il serait intéressant que des mycologues expérimentent les méthodes morphométriques proposées par la stéréologie au profit de la taxonomie des champignons.

BULLETIN OF MYCOLOGY. VOL. I. N°1, edited by Sultan AHMAD and S.H. IQBAL, Department of Botany, University of the Punjab, New Campus, Lahore, Autumn 1980.

We welcome the appearance of this new journal devoted to taxonomic mycology from Pakistan, a country where surely much waits to be discovered and described. The first issue of the *Bulletin of Mycology* contains interesting papers on freshwater Hyphomycetes, on coprophilous Ascomycetes, on Agaricales and other fungi from Pakistan. We hope that the new journal receives the attention that it deserves.

SEXUALITY AND PATHOGENICITY OF FUNGI, edited by R. VANBREUSEGHEM and Ch. DE VROEY, 250 p. ill., 8°, hard cover, 1981. Masson, 120 Bd. Saint Germain, 75280 Paris.

This is the Proceedings of the Third international Colloquium on Medical Mycology organized by the Prince Leopold Institute of Tropical Medecine, Antwerp, Belgium.

The question raised at the beginning of the colloquium "Is there a relationship between sexuality and pathogenicity to man in fungi?" received an answer far beyond any hope. That answer is that no relation between mating type and symptoms has been observed so far, but that a close relation between the mating type and the host or biotope is demonstrated and that that relation is determining particular geographical distribution. Beside the pathogenicity of mating types, serotypes, + and - types, sexual and asexual spores, many correlative aspects of the pathogenic fungi have been treated by the 32 contributors, like taxonomy and the relation anamorph-teleomorph, gentics, somatic hybridization, sexual stimulation, sexual test strains, filamentization of yeasts. The book answers a number of questions raised in the taxonomy and ecology of the fungi. It offers valuable readings for any mycologist and for plant pathologists.

YEAST GENETICS AND MOLECULAR BIOLOGY 1980. Reports, by A. GOFFEAU and J.M. WIAME. 102 p., 8°, paper back, 1980. Louvain-la-Neuve, Lab. Enzymology, Croix du Sud 1, 1348 Louvain-la-Neuve, Belgium. Price Workshop reports $ 10, Abstracts book $ 20.

This is the Workshop Reports of the tenth International Yeast Conference held at Louvain-la-Neuve, September 1980. It contains 24 plenary presentations covering the research progresses on *Saccharomyces cerevisiae* about its chromosome structure and replication, RNA, protein synthesis, cell cycle, sporulation, recombination, mutagenesis, radiation repair, expression of cloned genes, mating, regulation of C and N, metabolism, mitonchondria, killers, genetics engineering, evolution and taxonomy. It certainly leads to conclude that *Saccharomyces cerevisiae* is a favorite model for studying the structure and the operation of eukaryotic cells. The Abstracts Book was distributed at the Conference but is still available, it reproduces the abstracts of each of the 200 posters presented.

INTRODUCTION TO FUNGI, by John WEBSTER, 2d edition, 669 p., 331 fig. 8°, paper or hard cover, 1980. Cambridge University Press. P.O. Box 110, Cambridge, England. Price h.c. £ 30, p.c. 9.95.

After the publication of the first edition, in 1970, advances have been made in all fields of mycology. Where necessary the text has been altered or expanded. The literature cited is twice in number now. The author adopts the Ainsworth, Sparrow and Sussman's system of the Fungi, as a separate kingdom. The Myxomycetes are more extensively treated. The anamorphic fungi, the Deuteromycotina, receive a special chapter with a description of their conidiogenesis. New and detailed accounts are added on three ecological groups of fungi, the aquatic, the predacious and the seedborne imperfect fungi. This reinforces the aim of the author to be not purely taxonomical but to describe the fungi in their life behaviour. The clarity of Webster's writing, the precision of the data, the excellent selection of original photographs and drawings are prominent characteristics of the book. The book is an excellent manual for the university level. For reaching constantly the present limits of knowledges, it concerns all students of mycology.

HOW TO KNOW THE TRUE SLIME MOLDS, by M.L. FARR, in Pictured Key Nature Series, 132 p., 159 fig., 23x17 cm, spiral binding, 1981. Wm. C. Brown Co. Publ., 2460 Kerper Bd., Dubuque, Iowa 52001, USA.

This "pictured key" to the Myxomycetes is intended to be introductory and practical. The introduction shortly explains what Myxomycetes are, how they live, where they growth, how to collect them, how to keep them alive, how to look at them, how to describe them, how to preserve them. The keys to orders, families, genera and species are all dichotomous Specific descriptions, comments and illustrations are given at every species keyed out. Illustrations are mostly line drawings picturing fruiting bodies and, eventually, capillitium and spores. At every taxonomic level, indeed, the keys are constructed from both macroscopic and microscopic characters. They thus are not to be considered as field keys. They cover a selection of 276 common North-American species of Myxomycetes.

TAXONOMY OF THE INDIAN MYXOMYCETES, by T.N. LAKHAMPAL and K.G. MUKERJI. in Bibliotheca Mycologica vol. 78, 531 p., 40 fig., 8°, hard cover, 1981. J. Cramer, Fl 9490 Vaduz, Lichtenstein. Price: DM 120, subscription DM 96.

The authors have realised two aims. In the first part of the book, they describe, in a taxonomical order, all the species of Myxomycetes that they recorded in 1000 specimens from their respective collecting fields, i.e. Himalahal Pradesh and Delhi. The Taxonomy is that of Martin and Alexopoulos (1969) modified by Alexopoulos in Ainsworth, Sparrow and Sussman (1973). The illustrations are assembled in 28 full-page plates of black and white photographs of standard quality and 12 plates of rather poor line-drawings. In the second part of the book, the authors produce an updated index of all the Indian Myxomycetes records disposed in taxonomical order, with reference to the pertinent literature. The contribution is important. Out of the 450 presently known species of Myxomycetes, 293 are recorded in India and, out of those, 111 are recently recorded, by the authors mostly, after the publication in 1977 of Dr Thind's monograph.

BIODEGRADATION ET HUMIFICATION, ATLAS ULTRASTRUCTURAL, par G.M.OLAH, O. REISINGER et G. KILBERTUS, 334 p., 199 fig., 4°, cartonné, 1978. Les Presses de l'Université Laval, Québec. Librairie Vuibert, Paris.

En 1974, était organisé, à Nancy, le 1er Colloque international sur le thème "Biodégradation et Humification" (Mycotaxon IV(1):317, 1976).

Les auteurs, organisateurs de ce Colloque, ont rassemblé en un atlas leurs documents de microscopie électronique illustrant d'une part les agents de la biodégradation dans le sol (bactéries, champignons, algues bleues, et microfaune) et d'autre part les victimes, la matière organique vivante en dépérissement (celle des algues, champignons, bryophytes et phanérogames). L'atlas est divisé en chapitres introduits par un texte et un schéma expliquant le processus de la biodégradation dans le sol. Les illustrations font face à une légende brève, à mon avis trop brève, mais suivie d'un grand nombre de références à la littérature. Les photographies sont de bonne qualité et suscitent l'intérêt par leur choix et leur originalité. On y voit des vues inattendues de bactéries du sol ou colonisant des hyphes fongiques. Des images en ombrage et en transmission illustrent la sporulation de divers champignons, un asque operculé béant, des annellides, des conidies en grappe, des pores septaux, la perforation bactérienne de parois fongiques, la désorganisation enzymatique de celle-ci, et la repousse interne d'une hyphe de régénération. Cet atlas est didactique et permettra de visualiser, dans l'enseignement, un des grand phénomène de la biologie du sol, le "turn-over" de la matière organique.

COMPENDIUM OF COTTON DISEASES, par G.M. WATKINS, éd., in The Disease Compendia Series, n°5, 87 p., 45 fig., 59 ph. col., 4°, 1981. The American Phytopathological Society, 3340 PilotKnob Road, St Paul, Minnesota 55121. Prix US$ 11.

Ce compendium, comme les précédents sur les maladies du soya, du froment, de la luzerne, du maïs, continue une série fort utile à la clinique des plantes cultivées. Plus de quarante spécialistes ont contribué à la rédaction et l'illustration de celui-ci. Près d'une cinquantaine de champignons responsables d'une pathogénèse fongique du cotonnier sont envisagés, la symptomatologie et l'épidémiologie décrites et le traitement indiqué. A côté des maladies fongiques, les autres maladies biotiques et abiotiques sont aussi décrites et illustrées. Une clé synthétique des symptômes permet l'identification rapide des maladies.

THE CORTICIACEAE OF NORTH EUROPE. Vol. 6. PHLEBIA-SARCODONTIA, par John ERIKSSON, Kurt HJORSTAM et Leif RYVARDEN, p.1051-1276, fig. 535-653, 8°, broché, 1981. Fungiflora, P.O. Box 95, Blindern, Oslo 3, Norway. Prix Nkr 120.

Sont déjà parus et recensés dans Mycotaxon les volumes 2 (*Aleurodiscus - Confertobasidium*), 3 (*Cornicium - Hyphoderma*), 4 (*Hyphodermella - Mycoacia*) et 5 (*Mycoaciella - Phanerochaete*). Dans le présent volume, les auteurs décrivent les genres *Phlebia (31* espèces), *Repetobasidium* (8 espèces), *Piloderma, Resinicium* (3 espèces chacun), *Phlebiopsis, Radulomyces (*2 espèces) et*Physodontia, Plicatura, Plicaturopsis, Podoscypha, Pseudomerulius, Pseudoxenasma, Pulcherricium, Punctularia, Radulodon, Ramaricium, Repetobasidiellum* et *Sarcodontia* monospécifiques. Les auteurs proposent 1 nouveau genre (*Repetobasidiellum)*, 9 nouvelles espèces dont 3 en *Phlebia,* 14 nouvelles combinaisons dont 5 en *Phlebia* et un nom nouveau. Certainement, ce volume est attendu, comme le sont aussi les suivants.

THE FISCHER-SMITH CONTROVERSY: ARE THERE BACTERIAL DISEASES OF PLANTS?, par Erwin F. SMITH et Alfred FISCHER, introduit et traduit de l'allemand par C. Lee CAMPBELL, Phytopathological Classics n° 13, xviii + 65 p., 40 fig., 8°, broché, 1981. The American Phytopathological Society, St Paul, Minn., USA. Prix US $ 8.50.

Erwin F. Smith, American plant pathologist, USDA, Washington, who has demonstrated experimentaly the pathogenicity of bacteria to plants refutes the assertion of Alfred Fischer, a German professor in Botany at the University of Leipzig, of the non-existence of bacterial diseases. It was in 1897. Fischer answered by unjustifiable critics about the Smith's observations and experiments. Smith then took his own defence, in a long and convincing paper (1902). As a result, the existence of bacterial diseases was accepted, and the rivals were both promoted, the one as director of the USDA Plant Pathological Laboratory, Washington, the other as professor and director of the Botanical Gardens at the University of Basel."The facts are God's, the theories are human"(Lord Ripon, 1874).

TROPICAL MYCORRHIZA RESEARCH, par Peitsa MIKOLA édit., Oxford Science Publications, xii + 270 p., ill., 8°, relié, 1980. For the International Foundation of Science, Oxford University Press, Walton Street, Oxford OX2 6DP, England. Prix £ 15.

Ce volume est constitué des 31 communications présentées à l'International Workshop on Tropical Mycorrhiza tenu au Ghana, en 1978, par l' International Science Foundation (IFS). Elles se regroupent en quatre thèmes: les ectomycorhizes en région tropicale, les mycorhizes de la végétation naturelle, nutrition mycorhizique des plantes tropicales et mycorhizes des plantes agricoles. Il est intéressant de constater le rôle grandissant des ectomycorhizes dans la reforestation des zones tropicales dénudées. D.H. Marx fait une revue très large des possibilités d'inoculation de champignons mycorhizogènes, à travers le monde, et des méthodes utilisées. D'autres donnent les résultats particuliers obtenus en leur pays. La recherche explore aussi les mycorhizes naturelles des essences forestières et des plantes cultivées tropicales, en particulier de l'*Hevea*, de l'*Elaeis*, du cacaoyer, des *Citrus* et des graminées. Si on recherche les facteurs qui peuvent leur être favorables, on s'inquiète de plus en plus de l'effet néfaste sur les mycorhizes des fertilisations chimiques et des herbicides en forêt comme en agriculture. La mycorhization est un phénomène tel qu'il importe de le connaître pour le maintien du monde végétal et du nôtre.

DEVELOPMENTAL MICROBIOLOGY. par John PEBERDY, in Tertiary Level Biology Series, 230 p., ill., 12°, paper back, 1980. Blackie & Son Ltd. Bishopbriggs, Glascow G64 2NZ. Prix £ 8.50.

Ce petit livre de microbiologie est axé sur les phénomène de croissance et de reproduction. Il en montre les aspects les plus fondamentaux de structure, de biochimie et de génétique cellulaires et les plus apparents de la morphologie, de l'accroissement et de la formation sexuée et asexuée de spores, avec le souci d'expliquer la relation entre ces aspects. Si dans un tiers du livre il est question de bactéries et virus vus sous les mêmes aspects, ce livre est particulier par le choix des champignons comme matériel privilégié d'étude du développement (levures, myxomycètes, champignons filamenteux, champignons sexuées et asexuées). Ce livre est destiné au niveau du baccalauréat ou "undergraduate".

BIOLOGICAL MEMBRANES, THEIR STRUCTURE AND FUNCTION, par R. HARRISON et G.G. LUNT, Tertiary Level Biology Ser., 2e ed., 288 p., ill., 12° 1980. Blackie & Son Ltd., Glascow. Prix £ 7.95.

La structure de la membrane cellulaire, sa composition biochimique, les mécanismes fonctionels de reconnaissance des macromolécules et de leur transport par la membrane cellulaire sont les sujets traités par les auteurs dans un langage clair et adapté au niveau universitaire. Cependant nous regrettons que ce livre n'envisage que la cellule animale et qu'il ne mentionne qu'en passant les membranes végétale et fongique.

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NOTICES

XV PACIFIC SCIENCE CONGRESS

The XV Pacific Science Congress will be held February 1-11, 1983, in Dunedin, New Zealand. The Pacific Science Association is responsible for the program, which is sponsored by the Royal Society of New Zealand. A fisrt circular may be obtained from The Secretary General, 15th Pacific Science Congress, P.O. Box 6063, Dunedin North, New Zealand.

IMC$_3$: ON HOUSING COSTS IN JAPAN

Though it is indeed true that Japan is currently a very expensive place to visit, the organizing committee of IMC3 is well aware that most mycologists will not be able to spend great sums of money on housing for the congress. Dr. Keisuke Tubaki, a member of the Mycological Society of America's ad hoc committee on IMC3 arrangements, has assured us that though the meetings are planned for a downtown Tokyo hotel-convention facility, there will be many hotel rooms available close by in less prestigious hotels in the $15-20/night (1981 prices) range. There have apparently been rumors that housing costs would be substantially higher. Our Japanese hosts will do all they can to keep costs down for participants. The same concerns will be kep in mind for pre-congress and post-congress tours, workshops, and field trips. The Tokyo meetings will be from 28 August through 3 September, 1983.

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